

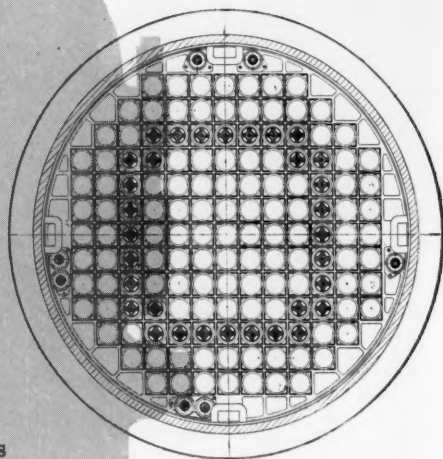
# SCIENCE

22 February 1957

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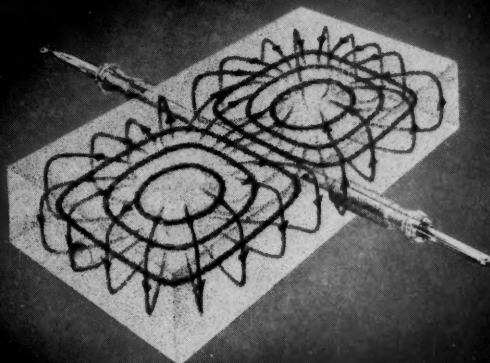
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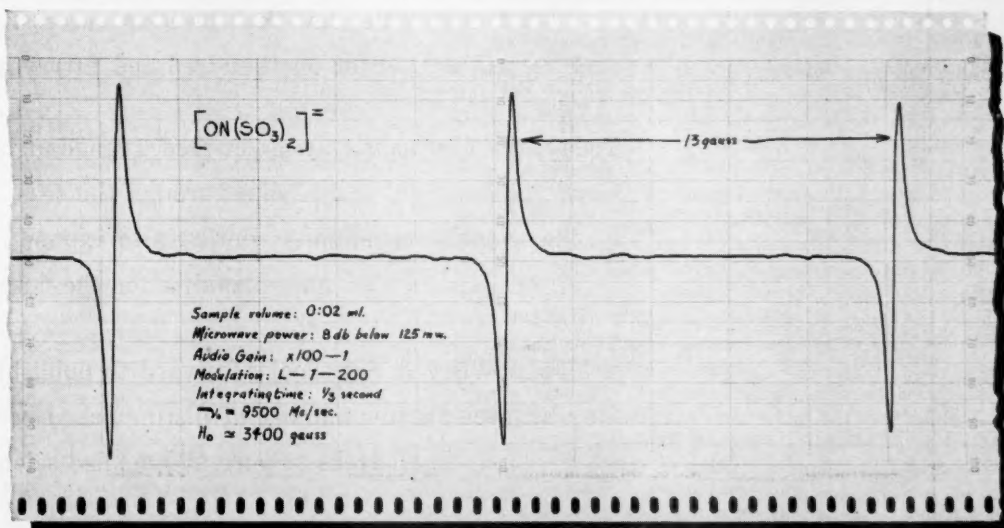
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## Atomic Power

The Atomic Energy Act of 1954 made possible private ownership of atomic power reactors and provided for the declassification of information of industrial interest. Although some progress has been made in developing commercial atomic power—the 60,000-kilowatt station at Shippingport, Pennsylvania, is nearing completion and several other stations are proposed or under construction—the pace has been slower than may have been desirable. Progress would doubtless have been more rapid if the Government had come to a clear-cut decision about the method of attaining rapid development. But no such decision has been made, and industry has been understandably reluctant to move into the field of atomic power while uncertainty about costs and risks prevails.

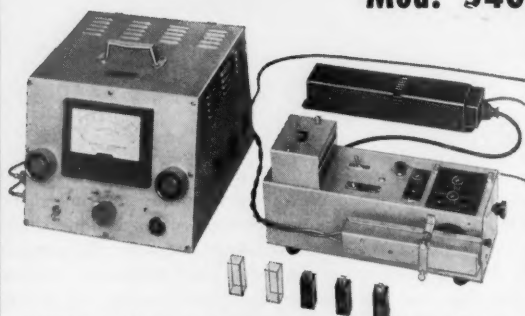
Several recent events suggest that the Government is moving toward a decision to push the atomic power program more vigorously and to take a larger responsibility for the production of commercial reactors. Last year the Panel on the Peaceful Uses of Atomic Energy (the McKinney Committee), which had been appointed by the Joint Atomic Energy Committee, recommended a partnership between Government and industry for the development of atomic power, but added that, if industry failed to take the initiative, the Atomic Energy Commission should support a program for the development of atomic power, including the construction of full-scale "demonstration" plants of several types.

The bill introduced by Senator Albert Gore in the last session of Congress would have authorized the AEC to spend \$400 million over a 5-year period in contracts for the development of reactors to show their practical value for the generation of electricity. It would in effect have authorized the AEC to carry out the alternative recommendation of the McKinney Committee. Despite opposition by four out of five members of the AEC and by the Administration, the bill was passed in the Senate by a close vote; it was, however, killed in the House by a narrow margin.

It seems probable that the attitude of the Administration toward the "partnership" program has changed recently. On 11 December 1956 Lewis L. Strauss, chairman of the AEC, who had formerly opposed a program of rapid development, shifted his position and urged a major expansion in commercial atomic power plants. And, in his budget message on 16 January 1957, President Eisenhower said: "If acceptable proposals for non-Federal construction of promising reactor types do not materialize within a reasonable time, a request will be made to the Congress for funds for direct construction by the Federal Government."

Whether or not this presidential statement implies that the Administration will not oppose Senator Gore's bill, which has been reintroduced in the Senate, is still uncertain. But it seems not unlikely that this bill or an Administration bill directed to similar ends may be enacted in this session of Congress. We hope so. For it seems to us none too soon for the United States to be in a position to supply practical power reactors to nations short of conventional sources of power and none too soon for us to develop commercial reactors as a hedge against the inevitable increases in our own demands for power in the near future.—G. DuS.

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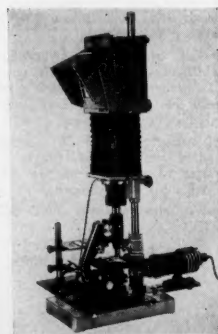
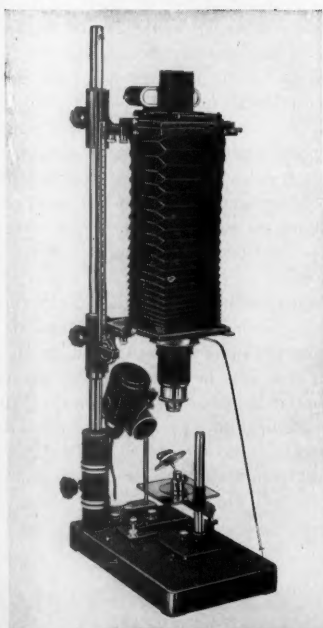
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## Communication by Insects: Physiology of Dancing

V. G. Dethier

The dances which foraging honey bees perform on their return to the hive and which serve to inform their nest mates of the presence of food, its direction, quality, and distance, constitute a pattern of behavior of considerably greater complexity than was once thought possible in insects. Both aspects of this exercise in behavior, namely, the presentation of information and the effective receipt of information, place equally severe demands upon the integrative capacity of the nervous system. A plausible rationalization of the ability to present information, in terms of the known capabilities of the insect nervous system, and a possible explanation of the origin of this ability are suggested by a series of observations of the responses of flies (*Phormia regina*) following stimulation by sugar (1).

### Behavior of Flies

The pattern of locomotion which a crawling fly displays on a horizontal surface under uniform lighting varies according to the exteroceptive stimuli encountered. For purposes of the present discussion, three conditions may be recognized: (i) the absence of specific stimuli; (ii) the continuous presence of stimuli; (iii) the withdrawal of stimuli. When it is placed in the first situation,

a fly tends to travel in a series of short (approximately 25 centimeters) straight lines connected in a random fashion as far as general direction is concerned. The second situation is exemplified by the actions of a fly which, in the course of its running, suddenly encounters with its tarsi a drop of sugar. The fly immediately halts and turns toward the point source of stimulation so that the mouth parts are brought over the spot. The proboscis is extended, and feeding commences. The fly remains in this position as long as the mouth parts are adequately stimulated. Thus, the characteristic locomotory response to continuous uniform stimulation is complete cessation of movement.

When walking on a paper evenly painted with a sugar solution, the fly adopts an irregular circuitous path (Fig. 1). This situation does not actually constitute continuous stimulation because, although the tarsal receptors are indeed constantly stimulated, the mouth parts are not. The tracks depicted in Fig. 1 represent mouth prints indicating where the fly sucked until stimulation ceased, whereupon locomotion was resumed. Therefore, this situation in fact represents typical behavior exhibited upon withdrawal of stimulation. In short, if the source of dominant stimulation is removed before the fly has fed to repletion or is removed as a result of the fly's having consumed it completely, the fly begins what, to all intents and purposes, appears as a purposeful searching action.

This action is most clearly seen in the case in which a fly is momentarily presented with a single drop of sugar. The response takes the form of repeated clockwise and counterclockwise turnings

in the area of the former drop (Fig. 2). That the action is completely stereotyped, rather than purposeful, is demonstrated by the fact that a fly which is held in the hand and stimulated with sugar, immediately upon being released on a horizontal surface, begins "searching" actions on the spot with no relation to the spatial location of the former stimulus. The action is purely automatic. Two features of this behavior are worthy of particular notice: (i) it takes place after the stimulus is removed and continues for some period of time; and (ii) it strikingly resembles a dance.

The intensity and duration of the response is modified by three variables: the concentration of the stimulus; the threshold of the central nervous system of the fly; and the time lapse between the withdrawal of stimulation and the onset of response.

For example, after stimulation with 0.1-molar glucose, there are few turnings, of short duration, before the fly resumes its former random-like mode of running (Fig. 3). After stimulation with 0.5-molar glucose, the fly exhibits a more convoluted action of longer duration. After stimulation with 1.0-molar glucose, there is still greater convolution and longer persistence of action. These actions differ, not in the acuteness—that is, degrees—of angles of turning, but in the number of turns per unit time and the total duration of action. The concentration with which the fly had been stimulated can clearly be predicted from the pattern of subsequent action.

For any given concentration of stimulus, the intensity and duration of response is related to the threshold of the central nervous system, and any change in the physiological state of the fly which alters this threshold is reflected as a change of response. The nutritional state of the fly thus affects taste acceptance thresholds (2, 3). A starved fly performs more active gyrations in response to 0.1-molar glucose than a fly which has recently fed. Flying also affects threshold. A fly which has flown for an hour, for example, responds more actively than one which has flown for only 10 minutes.

The importance of the third variable, time, with respect to the intensity of response is related to the decay in intensity. In other words, the rate of turning gradually diminishes as the action proceeds until there is complete cessation

The author is professor of biology at Johns Hopkins University, Baltimore, Md. This article is based on a paper presented at the symposium on the Communication of Insects sponsored by the North American section of the International Union for the Study of Social Insects during the AAAS New York meeting, December, 1956. The first part of this article was presented at the 10th International Congress of Entomology at Montreal, Quebec, in August 1956.

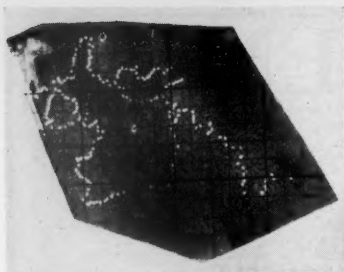


Fig. 1. Pattern of locomotion of a fly on a surface painted with a sucrose solution containing methylene blue. Each white spot represents a point where the labellum was appressed to the surface and the solution was sucked up completely.

and the fly resumes its random movements. Accordingly, any isolated segment of the action characteristically represents the elapsed time between the end of stimulation and the beginning of the particular segment. Since the rate of turning diminishes with time, a diffuse segment of the pattern represents a long time lapse, and a tightly convoluted segment represents a short time lapse. Furthermore, the longer a fly is prevented from responding after stimulation (by being held in the hand, for example), the less intense is the response.

If, at any time during the response, the fly is subjected to the continuing influence of some directional stimulus, such as light, the response acquires a directional component. The pattern of action becomes deformed by being elongated in a plane parallel to the beam of light (Fig. 4). In the dark the pattern is formless. If the fly is permitted to perform its gyrations on a vertical surface in darkness, in which case the continuing directional stimulus is gravity, the action acquires a directional component. The path is elongated parallel to the vertical axis. Light shining on the vertical surface destroys the directional component of the pattern (Fig. 5).

#### Resemblance to Bee Dances

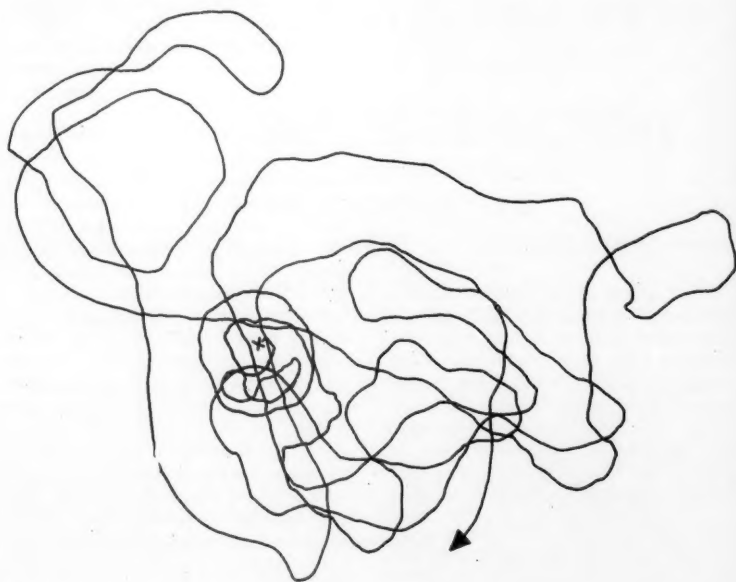
At this point it is clear that there are some striking parallelisms between the gyrations of the fly and the communicative dances of honey bees. With the fly, the intensity of reaction—that is, the number of turns per unit time—and the duration of the dance are related to the concentration of the initiating stimulus; with the bee, the vigor of the waggle dance and its duration are related to the concentrations of the nectar collected. With the fly, the rate of turning diminishes with time after stimulation so that, with a constant stimulus, any given elapsed time is reflected as circling of given intensity; with the bee, the number

of turns per unit time is related to the distance of the food from the hive, that is, flying time (but see subsequent paragraphs)—the greater the distance, the fewer the turns and the more diffuse the dance. With the fly, a continuing stimulus in the form of light or gravity imparts some direction to an otherwise disoriented action; with the bee, the orientation of the dance is related to the direction of light or polarized light when carried out on a horizontal plane and with gravity when conducted on a vertical plane in darkness. If the bee performs its dance on a horizontal comb in darkness, the dance is disoriented; that is, the successive runs point in different directions. The dance also becomes disoriented if light shines on the bee while it is dancing on a vertical comb.

Two major points of dissimilarity in the behavior of the two insects are immediately apparent: the gyrations of the fly possess intensity and direction but lack the clean geometric pattern so characteristic of the bee's waggle dance; the gyrations of the fly lack the precise angular orientation which is one of the main features of the bee's waggle dance. With regard to the first point, there is one important respect in which the circumstances of dancing bees generally differ from those of the circling flies—namely, the crowded conditions under which the bee usually dances. To simulate crowded conditions, a stimulated fly was forced in one experiment to perform in the midst of a crowd of other flies. Under

these conditions the action lost some of its diffuse character and acquired a crude geometry of pattern. Furthermore, an insect with short antennae which do not reach the ground makes up for its inability to palpate by crawling in wide, irregular paths. An insect such as the wasp *Polistes*, which palpates the ground with its antennae, can be made to perform a much neater dance than the fly.

With regard to the second point, it must be admitted that the fly cannot be induced to circle at any particular angle with respect to either light or gravity. The difference between the two insects may possibly be accounted for in terms of the highly developed light-compass reaction of the bee and its comparative unimportance in the life of the fly. In its normal relations with the environment, the honey bee relies heavily on a light-compass reaction for orientation at a distance, whereas the fly, although capable of some degree of light-compass response, is largely restricted to positive and negative phototaxis. In each insect, the behavior with respect to light has its counterpart in the effect of light on the orientation of the dance. In this connection it is pertinent to recall that Vowles (4) had postulated one taxis mechanism common to distance orientation to the sun, plane of polarization of light, and gravity and another taxis mechanism operating for orientation to near objects. Vowles regarded the first as the primary mechanism, and Thorpe



#### DAYLIGHT - HORIZONTAL SURFACE

Fig. 2. Pattern of locomotion performed in daylight on a horizontal surface by a fly which has been stimulated briefly with sucrose.



(5) indicated that the primary mechanism is innate and the other mechanism learned. The observations on the effect of light and gravity in the gyrations of the fly support these conclusions.

The comparison between bee and fly behavior may be carried one step further. When the foraging bee returns to the hive, it regurgitates nectar which is accepted by other bees. The forager then begins dancing, and as it dances its way among the crowd, other bees become excited to the point of following the dancer. When a fly which has recently been fed is placed in a crowd of unfed flies, it cleans its appendages and almost invariably regurgitates some of its crop load. Surrounding flies become greatly excited, follow the fed fly around, attempt to lick sugar from its mouth parts, and even begin gyrations of their own which are indistinguishable from those performed by the first fly. The superficial resemblance of this performance to that of bees dancing in the hive is striking.

Furthermore, if the first fly is fed with a sugar solution containing methylene blue, it is possible, a few minutes later, to detect the dye in the guts of many of the other flies. Clearly, both the fed fly and the foraging honey bee normally regurgitate; the bee disgorges nearly completely the contents of her crop; the fly only a fraction. The comparison suggests that the highly developed trophallaxis, or food-sharing, which goes so far in unifying the bee colony evolved from rather basic and simple individual behavior of the type exhibited by the fly.

It is not possible in the present context to carry the comparison of the two species further. The fly, being solitary rather than social, apparently does not act upon the information contained in the circling performance, beyond being excited enough to follow the circling individual until it flies away. The culminating act of the bee's dance—that is, the departure of stimulated members of the audience for the field—does not follow on the part of the flies. The stimulated flies do not go anywhere, nor would this final step logically be expected.

The circling response of the fly is a facet of adaptive behavior which serves as an effective pattern for food-searching. Since there are contained in it many of the basic components which characterize the waggle dance of honey bees, the possibility exists that the dance of the honey bee might have been derived from a primitive and basic behavior pattern of this sort. The many resemblances suggest this interpretation. This idea is also favored by the fact that there are dance patterns of various degrees of complexity from one species of bee to the next, and within a given species. For example, the Western honey bee, *Apis mellifera*, performs a wide variety of dances, ranging

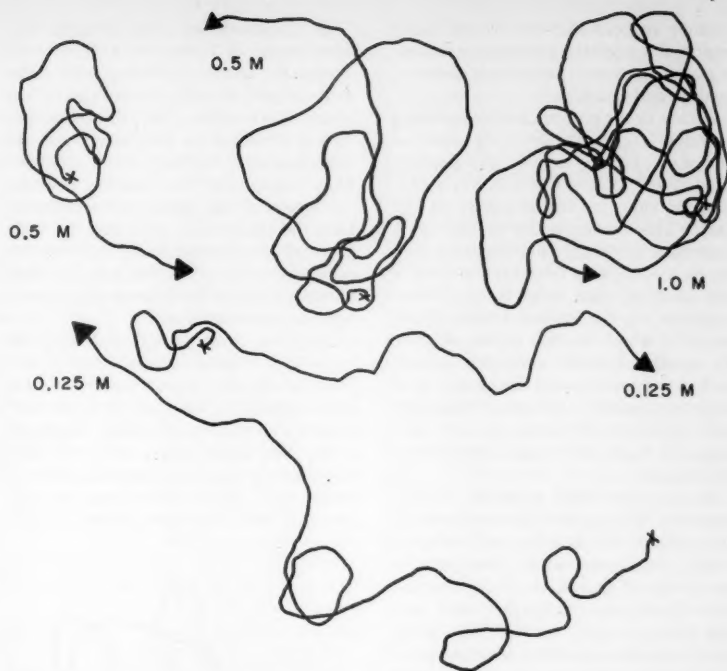


Fig. 3. Variations produced in the pattern of poststimulatory locomotion when the concentration of the stimulus is changed.

from formless gyrations to the highly stylized waggle dance (6, 7), and bees fed inside the hive run about excitedly but fail to perform an organized dance. Other species of bees, as, for example, *Apis florea*, perform dances of lesser degrees of complexity (8).

#### Relation of Dance to Stimulus and Response

The striking manner in which a fly's behavior can be described in terms of stimulus and response suggests the possibility of interpreting the waggle dance of the honey bee in similar terms. Although any attempt at complete interpretation at this time would suffer from gross oversimplification, a working hypothesis can be proposed which may direct further investigation into profitable channels. The hypothesis may be stated in the following terms: the waggle dance is a delayed response to effective taste stimulation and is regulated by a central nervous system threshold. It must be pointed out at the start that, while the hypothesis in its present form can explain many of the characteristics of honey bee dancing, it cannot explain all.

As von Frisch (9) proved, the waggle dance is coded to impart the following information: distance of food source from the hive, direction of food source from hive, and quantity and quality of

food. The nature of the food is indicated by the odor of the flower of origin, this odor adhering to the bodies of foragers and being contained in the nectar. This fact need not concern us here. Direction is indicated by the orientation of the dance axis with respect to light or gravity and, likewise, falls outside the scope of the present discussion.

The remaining data are coded principally as intensity of dance—that is, number of turns per unit time. They are also coded as duration of dancing. The code has certain ambiguities in that quantity, concentration, and distance may be signified by the same means, vigor and duration of dancing (9, pp. 113, 118). On the basis of this code alone, bees should be unable to distinguish between concentrated sugar at a distance and dilute sugar near at hand. That such is actually the case has recently been demonstrated by Boch (10). This state of affairs would truly represent an unfit adaptation for survival were it not for the fact that there is a safety factor in the form of a duplicate code. Distance of supply is also indicated by the site of dancing within the hive (10). For short distances, the dance is performed near the exit hole; for long distances, at a more remote position in the hive. In addition, the number of bees dancing also indicates distance, quality, and quantity. There may be other factors as yet unknown. The ambiguity



strongly suggests that the critical factor or stimulus regulating the dance is identical for the three parameters distance, quality, and quantity.

A clue to the nature of the controlling stimulus is given by an early observation of von Frisch—namely, that adulteration of the food in the field has a pronounced effect on the character of the dance. This finding points to taste as a controlling stimulus. The foraging honey bee on a round trip from hive to food is stimulated at least three times. Before departure the bee imbibes honey, in the course of which its oral organs of taste are stimulated; while collecting nectar, the bee is intermittently stimulated as it visits successively different blossoms; upon return to the hive, the bee disgorges its load and is stimulated for a third time.

There is one other possibility which cannot be overlooked. The presence of sugar in the fly's fore-gut, or mid-gut, or both has a pronounced effect on the taste threshold, most likely through mediation of receptors in the gut, since the crop seems to play no role (3). It is conceivable that a similar situation prevails in the honey bee, in which case stimulation could be effected without the oral organs of taste being stimulated.

If the dance is a delayed response to a taste stimulus, at which of the four moments of stimulation is control over the dance established? It might be argued that the first (fueling) and second (food-gathering) stimuli are too far removed in time to be effective. However, experiments with the fly overcome this objection. For both the bee and the fly the duration of the dance is the same, from a few seconds to 1 minute. For the bee, however, the elapsed time between stimulation at the site of food collection, for example (if this is indeed the moment of stimulation which is critical), is occupied by flying. In other words, another behavior pattern, flying, is interposed between stimulation and dancing. Since bees fly about 14 miles per hour and the maximum extent of foraging is usually 3 miles, the maximum duration of interpolated flight is from 15 to 20 minutes.

Can flying temporarily inhibit dancing? In the case of the fly, it has been demonstrated that a fly which is stimulated with glucose and forced to fly immediately thereafter will, upon the moment of landing, begin the circling which has been delayed by flight. Delays as long as 5 minutes have been recorded. If no flying is interpolated, the maximum delay before extinction of the response is of the order of 1 minute. Thus the possibility of the critical stimulation occurring at the time of fueling or collecting is theoretically tenable.

It is unlikely on other grounds that stimulation at fueling is a factor. Although the quantity of honey taken on as fuel is said to vary according to the distance to be flown (11), the concentration is constant, as compared with the concentration of nectar picked up in the field. Since there is a relation between the tempo of the dance and concentration, the importance of fueling tends to be ruled out. Furthermore, von Frisch's observation that adulteration in the field affects the dance tends to eliminate fueling from consideration.

Evidence that regurgitation may be concerned in releasing the dance is implied by the fact that a forager in the hive disgorges a bit, dances for a few seconds, stops, moves away, disgorges again, then again dances. So it is clear that dancing may occur after several regurgitations. On the other hand, the report that bees sometimes dance on the

landing board before regurgitating indicates that regurgitation is not invariably essential for dancing. In any event, there are ample opportunities for a taste stimulus to operate, and the time of stimulation, whether in the field while collecting, in flight through the mediation of internal receptors, or in the hive while disgorging the load, is not crucial to the hypothesis, since any of these eventualities can be accepted.

What is critical is the idea that the intensity of the stimulus is limiting. By intensity is meant, not the absolute concentration, but the concentration in relation to threshold. As the behavioral or central nervous system threshold changes, so does the dance of the fly change. Accordingly, for any given concentration of stimulus, if the taste threshold is high, the dance will be slow; if the threshold is low, the dance will be fast. Therefore, any factors which affect threshold may be expected to affect the dance. Two such factors are hunger and flight. Again in the case of the fly, experiments in our laboratory have shown that taste threshold drops in a regular fashion as flying time increases. The longer the flight, the lower the threshold.

The bee does not differ qualitatively in these respects. Direct measurements of the taste thresholds of individual bees have revealed that the tarsal, antennal, and oral thresholds decrease as the bee is starved (3). In our experiments the threshold of the bee had fallen to its lowest level about 60 hours after feeding to repletion with 2-molar sucrose. At this time the crop was nearly empty. The same striking drop in threshold could be brought about by flying the bee continuously for about 1½ hours. In each case renewed feeding was followed by a rise in threshold in excess of 30-fold.

#### Energy Expended in Flight

There are compelling reasons for believing that the critical variable regulating the intensity of the honey bee dance is energy expenditure (12). The work with flies demonstrates convincingly that there is a relation between energy expenditure and threshold. This is indicated by the fact that threshold decreases less rapidly as a fly is flown at low temperatures than when it is flown at high ones. Since wing-beat frequency and energy expenditure are greater at higher temperatures, the drop in threshold is clearly related to this factor rather than duration alone. But just what is meant by energy expenditure and just what relation does exist between this factor and threshold are still unclear. Several possibilities have been eliminated ex-

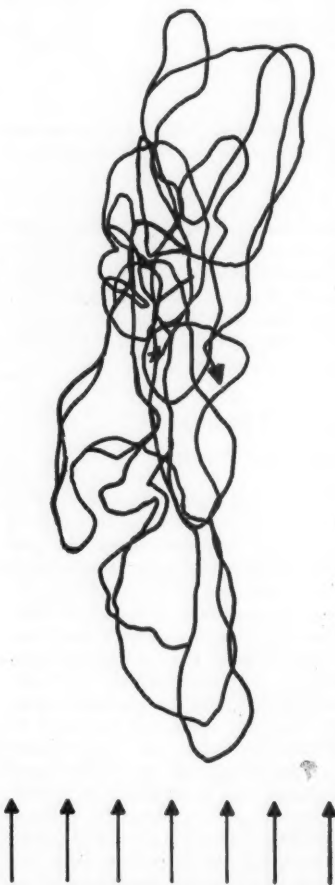


Fig. 4. Pattern of locomotion performed by a fly which is allowed to crawl on a horizontal surface in a beam of light after having been stimulated briefly with sucrose.

perimentally in the fly's case. Blood sugar level, glycogen level, and crop distention are not concerned (3). Present evidence suggests more strongly that some receptor mechanism within the gut is affected by the dynamic relation between the rate of utilization of carbohydrate and the quantity supplied. Similar experiments with the bee give no indication that this insect behaves any differently.

If, as seems to be the case, energy expenditure is the critical determinant for the dance, in which segment of the round-trip flight is the code laid down? Almost all workers agree that the distance which is coded is that of the outgoing flight. Khalifman (13) holds the opposite view that the return flight is critical. There is, however, an abundance of evidence to support the first view, and the adaptive value of the dance really requires that the characteristics of the outgoing flight be read from the dance. For example, von Frisch found that bees flying out against a headwind, and home with an assisting tailwind, indicate in their dances the outgoing distance. Heran (12) has shown that bees flying uphill on the outgoing flight and downhill on the return flight indicate the conditions of the outgoing flight.

The variables experienced in flight which affect the characteristics of the dance are duration, wind velocity and direction, grade of flight with respect to the horizontal, air temperature, and velocity of flight (12). These are reflected in the dance as follows: short distance, short duration, tailwind on outgoing flight, downhill outgoing flight, low temperature, and low velocity all cause the dance to be more intense (faster) and longer; long distance, long duration, headwind going out, uphill going out, high temperature, and high velocity all cause the dance to be less intense (slower). Heran (12) has concluded that the indicated distance, is coded through energy expended on the outgoing flight.

All attempts to understand the mechanisms of coding have been confounded by the fact that the dance correctly indicates the conditions of the outgoing flight. While Heran (12) clearly states that the hypothesis that the indicated distance is coded through expenditure of energy on home flights cannot be maintained, and further points out that the exact meaning and measurement of energy expenditure by the bee is uncritical, the role of the home flight should not yet be completely ruled out of the picture.

The hypothesis of control by taste threshold offers an explanation which merits further exploration. It is possible that the dance is regulated *inversely* by

events experienced on the homeward flight. For example, if the bee flies out against a headwind, it will return with a favoring tailwind. The energy expended on the return trip will be comparatively small, the taste threshold will remain high, the nectar collected will not constitute a very intense stimulus. Since the intensity of stimulation is a factor which can regulate dancing, the dance will be slow. Slowness indicates a long flight out, which in this instance is indeed the case. Conversely, if the bee flies out with a favoring tailwind, it must return against a headwind; the expenditure of energy will be greater; the threshold will be correspondingly low; the dance will be fast, which indicates a short flight out and is indeed the case. For headwind and tailwind one may substitute uphill and downhill, high flight velocity and low flight velocity, and the relation of these factors to dancing is similarly explained, since all affect threshold in identical fashion.

As attractive as this hypothesis may be, however, it fails to explain situations in which the outgoing and incoming flights are of equal duration and effort. It is clearly an oversimplification, yet

it does contain some features that fit the known facts, and further experimentation on energy threshold relationships might be profitable.

### Hypothesis Based on Proprioception

The only other major detailed hypothesis which has been proposed is that of Ribbands (14). It envisions the duration and intensity of stimulation of antennal proprioceptors by wind as regulating the dance rhythm. Heran (12), in studying the effect of wind velocity on dance characteristics, investigated this idea. Employing fixed bees, he found that the amplitude of wing beat decreased with increased wind velocity unless the antennae were amputated or fastened, in which case the change was smaller. From experiments of this sort he drew the conclusion that wind velocity was perceived by the antennae, that duration and intensity of wind faced provided a measurement of the distance flown, and that the dance shows a distance based on the duration and intensity of the air stream perceived on the outgoing flight.

But while it is true that proprioceptive information of the sort described is perceived through the antennae and that interference with antennal receptors prohibits compensatory regulations of flight, it does not follow that there is a causal relation between antennal proprioception and dancing. In other words, differences in velocity and the attending differences in flight characteristics mediated through antennal receptors assuredly affect the energy expenditure of the bee and presumably its threshold. Were it possible to remove the antennae without affecting flight, it is doubtful that the absence of proprioceptive input alone would alter the characteristics of the dance. The great difficulty in all conceptions which visualize stimuli experienced on the outgoing flight as having a direct influence on dancing is that the same stimuli experienced on the return flight must be ignored or subordinated.

### Importance of the Physiology of the Individual

No pretense can be made of explaining fully the physiology of the dances of honey bees in terms of the performance of flies. Yet the fact that a type of fly behavior resembling bee dancing can be described in terms of stimulus and response offers a basis for removing the phenomenon of bee dancing from the realm of mysticism and for explaining it in physiological terms. There seems



Fig. 5. Pattern of locomotion performed by a fly on a vertical surface in darkness after brief stimulation with sucrose.

to be adequate reason for believing that the communicative dance of bees represents a highly evolved form of primitive search pattern which is innate and stereotyped. There are many dances of bees, such as some of the transitional dances and dances signifying food close at hand [for example, the "pull dances" described by Hein (6) and the "sickle dances" described by Lindauer (15)], which are less stylized and uniform than the more widely publicized figure-of-eight waggle dances. Thus there appear to be all gradations between excited gyrations and organized dances in the Western honey bee, and from one species of bee to the next. It is not unreasonable to expect that these locomotory responses would be casually related to stimulation by food substances. Since taste threshold is clearly related to energy expended, taste stimulation offers a unique mechanism for a sensory measurement of expenditure.

Because the honey bee is a member of a complexly organized society there is frequently a tendency to regard it as a unit whose actions are subordinated to the needs of that society. Inherent in this view is the danger of considering the insect society as a superorganism (and indeed this view has at times been expressed in the classical literature) and, more dangerous still, of overlooking the

physiology of the individuals which constitute the society. The point is well illustrated by the mode of thinking which treats the crop or honey sac of the honey bee as community property which the bee dutifully fills in the field and as dutifully empties in the hive. The fact of the matter is that the crop of the honey bee is as much its own as that of the blowfly is its own. In both insects it is a place of storage, since both insects gorge themselves to repletion upon finding food. Both species use the contents of the crop freely for their own requirements. As postingestion time lengthens, the contents of the crop are directed to the mid-gut for the individual's own metabolism, and as the insects fly the contents are used as fuel. In both species there is a tendency to regurgitate when the crop is full.

In many respects, if the physiology and behavior of the individual are considered, much of colonial life seems to have its basis in stereotyped aspects of behavior which are seen to be fully developed in solitary insects but which have been adapted for the special needs of colonial life and for cohesiveness of the colony. But the physiological requirements and behavior patterns of the individual are not thereby abrogated. The parallelism between the "dancing" of the fly and the dancing of the honey bee

is a case in point. The fly and the bee alike are moved to dance by an innate response to a taste stimulus. In both insects the intensity of the taste stimulus is modified by the individual's nutritional state (16).

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## Useful Application of Bronsted Catalysis Law

G. M. Steinberg, R. Swidler, S. Seltzer

In several studies on the reaction between isopropyl methyl phosphonofluoridate (Sarin) and nucleophilic agents where these agents have been the anions of families of weak acids such as the catechols (1), hydroxamic acids (2), and oximes (3), it has been observed that, within each family of weak acids, a linear free-energy relationship of the Bronsted type (4, 4a)

$$k = G_B K_B^\beta = G_B \left( \frac{K_w}{K_A} \right)^\beta \quad (1)$$

exists between the rate of reaction and the ionization constant. In each case, the reaction was kinetically of the second

order and was found to fit the following equation.

$$\frac{dx}{dt} = k [\text{Sarin}] [\text{anion}] \quad (2)$$

In this reaction, 1 mole (or in some cases 2) of nucleophilic agent was consumed per mole of Sarin. However, if the nucleophile was maintained in large excess over the Sarin, the observed rate of the over-all reaction was first order, with the rate directly related to the concentration of anion. Under these conditions, the rate constant,  $k_{\text{obs.}}$  is defined by

$$k_{\text{obs.}} = k [\text{anion}] \quad (3)$$

Epstein, Rosenblatt, and Demek (1) have shown, in connection with their study of the rates of reaction between various catechols and Sarin, that, in aqueous solution under conditions of fixed pH and total concentration of reactant (anion plus free acid) for a series of compounds which exhibit a Bronsted relationship, there exists a very rapid reactant. The dissociation constant of this member of the series can be calculated by differentiating the observed rate constant with respect to the basic dissociation constant,  $K_B$ , of the reacting anion.

A relationship of this type, when applicable, can be of considerable practical value in the development of "best" reagents where rapidity of reaction is important, as for example in decontamination, detection, certain chemotherapeutic applications, and in analytic procedures. Thus, once the Bronsted relationship has been found to apply on the basis of a limited sampling (as indicated by a linear relationship between  $\log k$  and  $\rho K_A$ ), it is possible to predict which

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member of the series will give maximum rate and also to predict the actual rate that will be observed. It provides a means of pointing out the occasional exception that may provide leads to more rapid reactants. Also, in comparing compounds of different chemical types, one can make rough estimates of relative activity with available samples, even if  $pK_A$  is not near the optimum, since in most cases the values of  $\beta$  have been observed to vary between 0.3 and 0.9 (4).

The following discussion represents an evaluation of the relationship over a wide range of values of  $\beta$  (5) and its expression in convenient graphic form. Furthermore, the potential application of a relationship of this type in studies of biological assessment is indicated.

### Evaluation of the Bronsted Relationship

For purposes of comparison of the specific rate constants of the members of a series of weak acids (or bases) at constant pH under conditions where they are incompletely neutralized, and where only one member of the acid-base equilibrium relationship is active, we define a constant total concentration of acid and anion  $C$

$$C = [HA] + [\text{anion}] \quad (4)$$

where the relative concentrations of acid and anion are defined by the acidic dissociation constant,  $K_A$ ,

$$K_A = \frac{[H^+][\text{anion}]}{[HA]} \quad (5)$$

Under conditions where the reaction is observed to be kinetically of the first order (for example, the reagent is a catalyst, or if it is a reactant it is present in large excess) the rate will be defined by Eq. 3. By substituting Eq. 1, 4, and 5 into Eq. 3, we obtain

$$k_{\text{obs}} = \frac{K_A C G_B}{[H^+] + K_A} \left( \frac{K_w}{K_A} \right)^\beta \quad (6)$$

which describes the rate relationship among the members of any one series, with  $G_B$  and  $\beta$  the fixed constants for the particular series under the defined reaction conditions. The logarithmic form of this relationship is

$$\log_{10} k_{\text{obs}} = \log_{10} K_A C G_B - \log_{10} \left( \frac{K_w}{K_A} \right)^\beta \quad (7)$$

For general application of the relationship, it is most convenient to use the family of curves which are obtained by variation of the factors  $\beta$ ,  $K_A$ , and  $[H^+]$  in Eq. 7; the latter two variables are most conveniently handled in terms of the expression  $(pK_A - pH)$ . Figure 1 represents a plot of  $\log_{10} k_{\text{obs}}$  versus  $(pK_A - pH)$

for several values of  $\beta$ ; for purposes of convenience in calculation of the values of  $k_{\text{obs}}$ , the product  $C G_B$  has been arbitrarily assigned the value of  $10^{12}$  so that the values of  $k_{\text{obs}}$  are comparative.

Having previously ascertained the value of  $\beta$  from rate data on a few members of the series (it is the slope of the straight line that is obtained in a plot of  $\log_{10} k$  versus  $pK_A$ ), we may compare the relative values of the specific rate constants  $k_{\text{obs}}$  for the entire series (at a constant value of  $C$ ; Eq. 4) from the particular curve in Fig. 1 that has the nearest value of  $\beta$ .

The maximum rate at a defined pH may be described by the expression

$$\frac{d k_{\text{obs}}}{d K_A} = 0.$$

After appropriate operation on Eq. 6, we find that at maximum  $k_{\text{obs}}$ ,

$$pK_A - pH = \log \frac{\beta}{1 - \beta}$$

The broken line in Fig. 1 passes through the maximum in each of the curves.

Equation 6 applies to the specific case of a second-order reaction between substrate and the unprotonated (basic) member of a reagent which is in acid-base equilibrium, under conditions of constant pH and constant concentration of the reagent. The basic reactant may be either the anion of a protonic acid or a free base—for example, an organic amine. In the parallel case where reaction occurs between substrate and the protonated form of a reactant that is in acid-base equilibrium—for example, free acid or salt of a base—the resulting relationship under the conditions specified may be derived from the form of the Bronsted equation relating to acid catalysis,

$$k = G_A K_A^\alpha \quad (8)$$

and is given by

$$k_{\text{obs}} = \frac{C G_A [H^+] K_A^\alpha}{[H^+] + K_A} \quad (9)$$

where  $G_A$  and  $\alpha$  are constants which are fixed for a given reaction under defined reaction conditions, and the other symbols are as previously defined.

As a typical example, we may examine the reaction between hydroxamic acids and Sarin at pH 7.6. It has been determined that the  $\beta$  value for this reaction is 0.8 (2). Hence it can be predicted that maximum rate will be observed with a hydroxamic acid of  $pK_A = 8.2$  and that the observed rate will fall off much more rapidly by decreasing  $pK_A$  than by increasing it. Thus, a hydroxamic acid with a  $pK_A$  of 5.6 would react only 1/23 as rapidly as one with a  $pK_A$  of 8.2. Also, if for practical application, we would be satisfied with a rate that was, for in-

stance, as little as one-half of the maximum, we observe that we can use any hydroxamic acid in the  $pK_A$  range 7.2 to 10.0 ( $\log_{10} k_{\text{obs}}$  at max. = 6.18; therefore at  $k_{\text{obs}}/2$ ,  $\log_{10} k_{\text{obs}} = 5.9$ ). However, it should be noted that if maximum reaction rate is desired, and if there are no limitations placed upon the pH of the reaction system, the most rapid reaction will occur with the member of the series having the highest  $pK_A$  at a pH at which it is "completely" dissociated—that is, at  $pH = pK_A + 2$ .

### Possible Application to Biological Assessment

Studies at constant pH are of prime importance to the physiological chemist. It was of interest to determine whether a similar relationship could be observed between ionization constant and physiological activity within a series of weak acids or bases. Others have noted correlations between physiological activity and ionization constant (6, chapter 4). However, the type of relationship described by Eq. 2 or 8 represents a potential improvement over simpler correlations because it defines a wide range of permissible relationships. These may vary between the limits  $\beta$  (or  $\alpha$ ) = 0 (zero correlation between functions—for example, all members of the series are

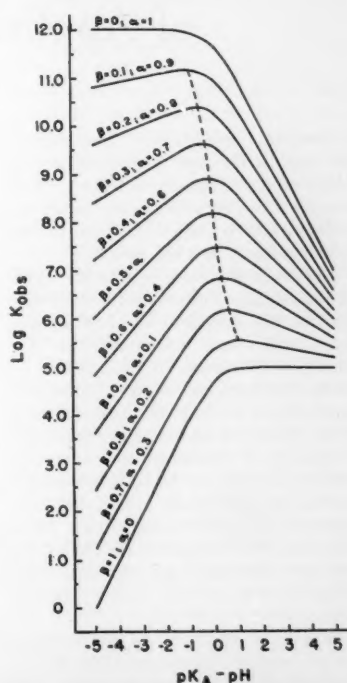


Fig. 1. Family of curves defined by Eq. 7 and the logarithmic form of Eq. 9.



equally active) to  $\beta$  (or  $\alpha$ ) = 1 (where the correlation is 1 to 1).

Detailed examination was made of two systems: the bacteriostatic effectiveness of a series of acridines (6, p. 84 and Appendix I) at pH 7.2 to 7.4 and the similar activity of a series of sulfonamides (7) at pH 7. In the first system, it was observed by Albert (6, p. 84 and Appendix I) that the active principle is the acridinium cation and that structural modifications are of minor importance in determining activity compared with that of  $pK_A$ . We plotted log activity (8) versus ( $pK_A - pH$ ) and, in agreement with Albert, we observed an  $\alpha$  value of near 0. With the sulfonamides, activity is believed to reside primarily in the anion.

Bell and Roblin (9) obtained a nearly symmetrical, bell-shaped curve when they plotted log activity versus  $pK_A$ ; but they were unable to develop a completely satisfactory mathematical relationship to fit their data. Their curve corresponds to those in Fig. 1 with a  $\beta$  value of 0.5 or 0.6 in that the maximum is correctly located; however, the slopes of both limbs

of their observed curve are far too great to be accommodated by either of those from Fig. 1 or their own mathematical relationship. An attempted correction by Bell and Roblin for activity that might be due to the free acid gave only slight improvement. We examined the possibility that the free acid also was active and that its activity was related to  $pK_A$  by the exponential relationship (Eq. 8) and found that a very satisfactory fit could be obtained if one assumed a  $\beta$  value of 0.6 for the anion and an  $\alpha$  value of 0.4 for the free acid.

Subsequent to the report of Bell and Roblin, several attempts were made to develop mathematical expressions to fit the data based on postulated mechanistic sequences of action. The most successful was that of Northey (7), who developed a satisfactory equation based upon the assumptions that activity within the cell was due to the anionic species and that the protonated form was essential to penetration through the cell wall.

Thus, it would seem that the relationships discussed in this paper are also of

potential value in correlating physiological activity with dissociation constant and may be worthy of further examination in the field of biological assessment.

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## E. L. DeGolyer, Father of Applied Geophysics

Everette Lee DeGolyer, renowned as the world's foremost geologist and the father of applied geophysics, died 14 December at the age of 70, in Dallas, Texas, ending a half-century of brilliant service to the industry and the nation.

DeGolyer was born 9 October 1886, of homesteader parents, near Greensburg, Kansas. He attended the Joplin, Missouri, high school and entered the University of Oklahoma in 1906. There he studied geology and worked during the summers for the U.S. Geological Survey in the Rocky Mountain area. He left the University of Oklahoma as a senior, in 1908, to work for the Oklahoma Geological Survey and in the fall of 1909 accepted a job as field geologist for Mexican Eagle Oil Company, Ltd. While he was with Mexican Eagle, he staked the discovery well of the Tierra Amarilla field.

When DeGolyer staked the location for the prolific Potrero del Llano No. 4, he attained his first geologic fame. The well ultimately produced more than 100 million barrels.

DeGolyer returned to the University of Oklahoma in 1911 for his A.B. degree in geology. During this period he married Nell Goodrich, daughter of an Oklahoma City dentist.

In 1914 DeGolyer left Mexican Eagle and set up a consulting practice at Norman, Oklahoma. He made a geologic reconnaissance of western Cuba in 1915 and in 1916 opened a consulting office in New York. In 1918 he went to work for the U.S. Treasury, and his resulting study of Gulf Coast production-decline curves was incorporated in the Treasury's *Manual for the Oil and Gas Industry under the Revenue Act of 1918*. In 1919 he organized Amerada Petroleum Corporation for Sir Weetman Pearson and built the company into one of this country's most successful independent oil firms. Amerada's success was due largely to DeGolyer's pioneering efforts in oil geophysics, and it was during this period that he successfully directed the first geophysical survey of an oil field in the United States—a torsion-balance survey of prolific Spindletop field. The first salt

dome and oil structure discovered in the United States by any geophysical method was the Nash Dome in Brazoria County, Texas, found early in 1924 by a torsion-balance survey made by the Rycade Oil Corporation, of which DeGolyer was president. DeGolyer also introduced the refraction and reflection seismic method of exploration and was well known for organization work throughout the industry.

In addition to organizing Amerada, he established the Geophysical Research Corporation and Geophysical Service, Inc., and was instrumental in the organization of Core Laboratories, Inc. In 1936, together with Lewis W. MacNaughton, he formed an association which resulted in the oil appraisal concern of DeGolyer and MacNaughton. The most recent product of his organizational genius was the founding of Isotopes, Inc., in 1955.

The oil and gas industry bestowed upon DeGolyer its most prized awards for his outstanding service. In addition to a host of honorary degrees and memberships, these include the Texas Mid-Continent Oil and Gas Association's distinguished service award, in 1939; the Anthony F. Lucas medal of the AIME, in 1941; the John Fritz medal of the Founder Societies (ASCE, AIME, ASME, and AIEE), in 1942; and the AAPG's Sidney Powers memorial award in 1950.

At his death, DeGolyer was senior chairman of the board of DeGolyer and MacNaughton and an active member of many other boards, including Louisiana Land and Exploration Company, Republic Natural Gas Company, Southern Pacific Company, General Minerals, and



Christian Oil Corporation. Because of failing strength, he had recently resigned from the boards of Dresser Industries and Texas Eastern Transmission Corporation.

His phenomenal energy spilled over into other fields. He was nearly as well known in the literary world as in the oil industry. At one time he was controlling

owner of the *Saturday Review*—a publication he brought back from the brink of bankruptcy—and an expert on historical and geographical literature of the Southwest and of the Spanish influence on this region. He was interested in the activities of the Smithsonian Institution, of which he was a regent.

DeGolyer was the scientist-executive,

amazingly adept in the field of human relations. Through exceptionally clear thinking and a superb sense of timing, he was able to draw in his associates in the formation of an idea, enabling them to see clearly the same mental image that he himself visualized.

LEWIS W. MACNAUGHTON  
Dallas, Texas

## E. P. Adams, Princeton Physicist

At the beginning of the century the department of physics of Princeton University consisted of only four men—C. F. Brackett, W. F. Magie, E. H. Loomis, and H. McClenahan—but the University must already have started to plan for a considerable expansion of the department. In 1903 those four were joined by P. E. Robinson and E. P. Adams, the latter having just completed 4 years of graduate work at Harvard, Berlin, Göttingen, and Trinity College, Cambridge, after taking his bachelor's degree at Beloit College in 1899.

In 1906 two further additions to the faculty in physics were made. These were O. W. Richardson from England and Augustus Trowbridge from Wisconsin, and with them the department took on a new activity in research in which Adams was an active participant. At this time he was very much interested in experimental research, and he directed the work of a number of graduate students. His interests were wide enough to encompass work in radioactivity, contact differences of potential, electromagnetic wave propagation, electrostriction, dielectric constant, and the Hall and Corbino effects.

In 1905 Princeton had also brought to its mathematics department the already famous James H. Jeans, who introduced new lecture courses in theoretical physics. When Jeans returned to England in 1909 this type of instruction had to be continued, and Adams was the individual who proved willing and able to step into the breach. In consequence, his research activities shifted gradually from experiment to theory. It was during this period, in 1913–14, that I first knew him, when I listened with great pleasure and profit to his senior course in electricity, using

Jeans' *Electricity and Magnetism* as a textbook. Those lectures formed the strongest of my recollections of undergraduate days when I returned to graduate work, 5 years later.

World War I did not provide many outlets for physicists, but there was one very active field of work in sound-ranging. In 1917 Adams went on leave from Princeton University to join the Royal Engineers of the British Army for active service in France with a sound-ranging company, where he remained until his demobilization in March 1919. In recognition of his services he was made an Officer of the Order of the British Empire.

At the time that he returned from the war, Adams was considered one of the leaders in theoretical physics. He was, therefore, commissioned by the National Research Council to write a report on the existing state of the quantum theory, which had had a considerable development using classical ideas with superimposed quantum conditions, as in Bohr's atomic theory. Adams' report appeared in 1920, with a second edition in 1923, and was an authoritative textbook for a considerable number of years. He also at this time (1922) edited *The Smithsonian Mathematical Formulae and Tables of Elliptic Functions*. The most striking theoretical development of the period, the theory of relativity, also attracted Adams, and he was the translator for the lectures that Einstein gave in Princeton in 1921, which appeared as *The Meaning of Relativity*.

After these excursions into the new theories, Adams returned to his older loves and worked assiduously in the fields of classical electricity and mechanics.

His courses in these subjects, as well as in statistical mechanics, were models of clarity, simplicity, and completeness. They form for me, and I know for many other Princeton graduate students, the most vivid memories of our student days.

Adams succeeded K. T. Compton as chairman of the physics department when Compton was called to the presidency of Massachusetts Institute of Technology, and he served in that capacity from 1931 to 1935, when he was succeeded by H. D. Smyth.

In the 1920's Adams was an enthusiastic horseman; because of his great height, about 6 feet 6 inches, and the small size of the horse he rode, he became known to the students as the "professor who goes out walking with a horse under him." Unfortunately this pastime proved disastrous; he was thrown from his horse and severely injured. His recovery from the accident and from the subsequent complications was slow and left his health permanently impaired. In spite of this he continued to work very actively, and indeed even after his retirement in 1943 his chief occupation was mathematics and its application to physical problems. In a letter written in October 1956, he remarked about the teaching of physics: "I still think there must be a solid foundation of Newtonian and Maxwellian physics, but how to make the transition to quantum and relativistic physics is what puzzles me. It seems as if it were about time for some new revolutionary principle to be evolved to do away with the discovery of new elementary particles."

Professor Adams was a rather difficult person to know, but once one had broken through into his friendship one found him a genial host and a man of subtle humor. He was a great lover of classical music and had even taught himself to play the piano with sufficient skill to get great enjoyment from it. He was a gentleman in the truest sense and of a kind which is becoming more and more rare. His personality will not be easily forgotten by the many Princeton graduate students who came under his influence, nor by his friends and colleagues.

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## News of Science

### NAS-NRC Closes Coordination Center

The National Academy of Sciences-National Research Council announces with regret that the Chemical-Biological Coordination Center, now in its eleventh year of operation, is to be discontinued. Although there has been widespread agreement among scientists familiar with its activities that the center has great potential value to science, financial backing adequate to continue the center at an effective level of operation has not been found. Over the years, support has been provided from within the Government by the Army and Navy, the National Institutes of Health, the Atomic Energy Commission, and the National Science Foundation; and from outside the Government by the American Cancer Society. But despite the efforts of those agencies, the funds available for the center have decreased while its steady growth has called for an increasing level of expenditure. The point has finally been reached where its effective operation is no longer possible.

No scientist is unaware of the problem posed by the expanding volume of scientific information, both in the published literature and in the mass of test data lying generally unavailable in internal reports and file cases. There is no better example than that of research on biological responses to chemicals. Recognizing more than 10 years ago the eventual necessity for some scheme of collection and correlation of chemical-biological data, a small group of scientists who had struggled with certain aspects of this problem during World War II proposed a center to investigate methods for realizing such a scheme. Parent of the project was M. C. Winternitz, whose enthusiasm and vision rallied supporters for the organization that was to be called the Chemical-Biological Coordination Center.

With a small staff and the files of the war-time Office of Scientific Research and Development Insect Control Committee as a beginning, the center embarked on an uncharted course. The history of the first years records the contributions of many scientists to the major problem of converting chemical-biologi-

cal information to a coded form that could be recorded and sorted by machine methods. Gradually, through several stages, a Chemical Code and Biology Code took shape, both designed for use with IBM punched cards. Finally, a time arrived when it was clear that the codes were at a stage at which their further improvement could best come about through actual use. The Chemistry Code, which was published in 1950, has been used since that time with no major changes and with gratifying success in the retrieval of chemical information. It has been adopted by a number of other organizations, with some modification to meet their particular needs.

The Biology Code has gone through six mimeographed editions but has not been published because of its continuing state of evolution and expansion to meet the changing requirements of the material with which it deals. It has now reached a stage, however, where its publication is justified, together with the "key" containing essential explanations and directions for the use of the code.

For 6 years the center has been collecting data from a selected list of publications, from unpublished sources, and from its own screening program, a program in which the center has acted as liaison between submitters of compounds and a series of independent laboratories carrying on biological tests. As a result of this activity, each year has marked some improvement in the method of handling data, in the codes, in the caliber and speed of coding, and in the size of the files.

As the center has developed, it has been considered to serve three main purposes. First, with its codes and machine methods and its growing files, it has steadily built up its capacity for the discovery and exploration of systematic correlations between chemical structure and biological activity or between different biological actions, relationships that might be recognized only through large-scale machine correlating. In that sense, the center has had the potential of becoming a unique tool for creative research.

Second, the center has provided an increasingly useful bibliographical resource because of its vast accumulation

of information on the biological actions of chemicals. Despite its small staff and the handicap of its developmental difficulties, the center has become a source of information that some agencies have learned to consult regularly. Even though the files have by no means represented complete coverage of the available data, these agencies have recognized them as containing much information unobtainable elsewhere and as providing data not revealed by mere title and author indexes.

Third, the center has developed a background of research and experience on the methodology of data handling in the chemical-biological field that has enabled it to improve its own techniques and to advise other organizations from time to time in the establishment of their files. This is an aspect of the center that has been considered of prime importance, both as a service to others and as a contribution to the management of the formidable information-handling problems of science generally.

Processing of data into the files of the center has now been stopped. The screening program, which served a unique function, has been discontinued except for final details. The final closing operations will probably continue over the next 5 or 6 months. It is expected that the Biology Code and Key will be published; that final information from the screening program, which would not otherwise be generally available, will be published in the concluding volumes of the center's regular series of *Summary Tables of Biological Tests*; and that a history of the center will be prepared.

Of the greatest concern is the disposition of the master files of chemistry and biology code sheets (containing written abstracts as well as data in code) and of the IBM cards which index the code sheets in as many ways as the punching allows. Every effort will be made to retain these files intact. In the meantime, some sections of the files will be duplicated to meet particular needs that have been presented. As the staff dissolves, however, further requests will become increasingly difficult to accommodate.

The files have reached such proportions that they have created space problems. This situation points to the eventual need for other machine methods of storage and sorting, perhaps the substitution of magnetic tape for punched cards. The master file consists of nearly 100,000 biology code sheets and more than 63,000 chemistry sheets, which occupy 21 standard file cabinets (84 drawers). There are three chemistry card files of 63,000 3- by 5-inch index cards each (name, serial number, and molecular formula files). The total number of IBM cards, necessary for efficient information searches, is more than 1.5 million; these

occupy 21 22-drawer steel card cabinets. The basic sets of punched cards correspond in number to the 63,000 coded compounds and 218,000 lines of biology data (on the 100,000 biology code sheets); rearrangement of these into subsidiary files to facilitate searching accounts for the balance of the 1.5 million cards. A file is also retained of all original reports of test results from the screening program.

The Chemical-Biological Coordination Center has achieved much in the 11 years of its existence. Briefly, it has developed and tested a practical, functioning pattern for a center for chemical-biological information. But that accomplishment has embraced many things. Chemical and biological codes have been developed and their utility has been thoroughly tested on a large and diverse body of data. Coding and checking procedures have been worked out in practice. Machine-handling techniques have been successfully demonstrated in actual correlation studies. And the practical business of coding, filing, and handling of chemical-biological data on a large scale has been reduced to an everyday routine.

The Academy-Research Council is indebted to the hundreds of scientists who have taken part in the development of the center, and to the devoted staff that has carried out its actual operations; their vision has been great, their service to science notable. The experience and accomplishments, the shortcomings and difficulties, of the center demonstrate important lessons for similar undertakings that will inevitably be necessary in the future if science is to learn how to manage its own output.

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### AEC Industrial Hygiene Awards

Prospective applicants have until 1 Mar. to file requests for appointments in the 1957-58 Atomic Energy Commission special fellowship program in industrial hygiene. This program, which leads to the master's degree in industrial hygiene, is administered for the commission by the Oak Ridge Institute of Nuclear Studies. Fellows enroll for an academic year of graduate training in the subject at the Harvard University School of Public Health or at the University of Pittsburgh Graduate School of Public Health.

Basic fellowship stipend is \$2500, with an additional \$350 allowed for spouse and each dependent child. Awards include payment of normal tuition and fees required by the university; a travel allowance of 6 cents per mile for the fellow from the place of application to his

assigned university; and financial assistance to attend the annual meeting of the American Industrial Hygiene Association. One or more years of graduate experience may qualify a fellow for an additional \$200 in the basic stipend.

Requirements include a bachelor's degree in engineering or a basic science, acceptability for graduate work at the university he selects, and U.S. citizenship. Applicants must be under 35 years of age. Additional information and application blanks may be obtained by writing to the Fellowship Office, Oak Ridge Institute of Nuclear Studies, P.O. Box 117, Oak Ridge, Tenn.

### Research Funds

A review of the flow in 1953 of research and development funds was recently completed by the National Science Foundation. The review analyzed both the sources of the funds and their expenditure, the flow totaling \$5.4 billion, which is 1.5 percent of the gross national product.

The sources of the funds were these: the Federal Government, \$2.8 billion, or 52 percent; industry-oriented organizations, \$2.4 billion, or 44 percent; colleges and universities, \$130 million, or 3 percent; and other institutions, such as privately endowed foundations, \$50 million, or 1 percent. The contribution by colleges and universities does not include such items as salaries for principal investigators.

The funds were spent in research and development as follows: the Federal Government, 18 percent; industry-oriented organizations, 72 percent; colleges and universities, 9 percent; and other institutions, 1 percent.

Thus, in 1953, the Federal Government used about one-third of its \$2.8 billion for conducting its own research, with the remainder dispersed through contracts and grants to other organizations. Industry spent virtually all of its \$2.4 billion, with a very small amount going to colleges and universities. And the colleges and universities spent a sum equal to 3 times their contribution.

### Insect Physiology

The *Journal of Insect Physiology* will begin publication in March. This is an international journal which plans to bring together in one place the best contributions on insect physiology from all parts of the world. The journal is to be published by Pergamon Press in London. Manuscripts should be sent to one of the following editors: Prof. V. G. Dethier, Department of Biology, Johns Hopkins University, Baltimore, Md., U.S.A.; Dr.

H. E. Hinton, Department of Zoology, University of Bristol, Bristol, England; or Prof. M. Lüscher, Zoologisches Institut der Universität Bern, Bern, Switzerland.

### Instrument Stations in the Deep Sea

Heretofore it has been difficult to moor instrument stations in the deep sea, and their effectiveness was limited even for the few days that they continued to function. However, during recent operations in the Pacific, a group from the Scripps Institution of Oceanography succeeded in mooring instrument stations in depths of from 3200 to 4700 meters. They were installed for the purpose of obtaining synoptic data over a large area. The moorings employed taut wire and a primary float below the level of wave action. (Earlier installations of similar stations had been set at about 700 fathoms.)

The stations were equipped with recorders, vertical instrument strings, power supply, lights, and radar targets. Sixteen of these units were maintained for a period of more than 4 months in the region of the northeast trades. Highest wind velocities during the period were about 37 knots. Natural attrition accounted for the loss of surface components of two stations, but parts of several of the moorings were recovered at the end of the period and were in excellent condition. Therefore, it would appear that the basic problems of kinking, chafing, and electrolysis have been solved.

The maximal horizontal excursion of the instrument station in the extremes of weather and current during the test period is unknown, but it was not more than the limits of accurate navigation—that is,  $\pm 1$  mile. Calculations indicate a total excursion of the submerged float to have been  $\pm 300$  meters under the extreme conditions.

Installation of a mooring required about 45 minutes after arrival on station, exchange of the instrument platform took about 15 minutes on subsequent visits. Cost of the moorings, exclusive of the surface platform and instrumentation, was about \$700 each.

It is believed that this development, which was supported by the Office of Naval Research, will find important application in exploration of the deep ocean. A discussion of the method and a detailed description of the technique are in preparation and will be available upon request from the director of the Scripps Institution of Oceanography.

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## AEC Radiation Protection Standards

The Atomic Energy Commission has issued a regulation, effective on 28 Feb., that establishes standards for the protection of atomic energy workers and the public against radiation hazards arising from activities licensed by the Commission.

The regulation was first published in July 1955 as a proposed rule. It has since been submitted for comment to many interested persons and organizations, including state governors and state health and labor commissioners, and the commission has had the benefit of numerous comments and suggestions. An Advisory Committee of State Officials, appointed by the commission, has twice met in Washington to consider and comment on the regulation.

The commission will continue to work closely with the states to seek their advice and keep them informed of commission action in the health and safety field and, when they request, to advise and assist the states on their related regulatory programs.

Standards are set up in the regulation for the handling of all radioactive materials subject to commission licensing—special nuclear materials such as uranium 233 and uranium 235, source materials such as natural uranium and thorium, and by-product materials (radioisotopes). Limits are prescribed governing exposure of workers to external radiation, concentrations of radioactive material which may be discharged into air and water, and disposal of radioactive wastes.

Other provisions of the regulation include requirements for surveys of radiation hazards by licensees, monitoring of workers, caution signs, labels, and signals, storage of licensed material and instruction of workers on safe procedures for handling and using licensed materials.

Permissible limits, which except for minor changes are the same as those contained in the earlier proposed regulation, agree substantially with the current recommendations of the National Committee on Radiation Protection in National Bureau of Standards Handbook 52, *Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water*, and NBS Handbook 59, *Permissible Dose from External Sources of Ionizing Radiation*.

The National Committee on Radiation Protection has under review recommendations to limit cumulative exposures over periods of years. The commission is giving consideration to appropriate amendments to its regulations to deal with this cumulative exposure problem.

It is believed, on the basis of present knowledge, that the standards provide an

adequate margin of safety for exposed persons. It is emphasized, however, that the standards are subject to change with the development of new knowledge, with significant increase in the average exposure of the whole population to radiation, and with further experience in administration of the regulatory program.

The new AEC regulation applies only to activities licensed by the commission. It does not cover radiation sources such as x-ray and radium. One of the purposes of the regulation, however, is to assure that exposures to radiation from licensed material, when added to exposures from unlicensed radiation sources possessed by a licensee, such as x-ray and radium, do not exceed the permissible limits.

## Cold Spring Harbor Courses

The Biological Laboratory of the Long Island Biological Association at Cold Spring Harbor, N.Y., will offer three specialized courses next summer that are designed to acquaint research workers with the most important techniques used in bacterial virus research, bacterial genetics, and genetics of fungi. The course in bacterial viruses, to be given by G. Streisinger, will run for 3 weeks beginning 17 June; the course on genetics of filamentous fungi (*Neurospora* and *Aspergillus*) will be given by R. W. Barratt and Etta Käfer for 4 weeks beginning 8 July, and the course in bacterial genetics, to be given by M. Demerec, Evelyn M. Witkin, and V. Bryson, is scheduled for 3 weeks beginning 5 Aug.

## Heart Drug Evaluation Program

The U.S. Public Health Service has announced a grant of \$575,000 to evaluate the effectiveness of drugs in treating heart disease. This is the largest research grant of its kind ever made by the National Heart Institute. The grant was made to Alan E. Treloar, director of research of the American Hospital Association, to carry on a nation-wide program that will coordinate the activities of a number of research teams. The initial study will be concerned with the problem of hypertension.

According to present plans, an advisory board of eminent medical research workers and clinicians will be responsible for establishing guiding principles for the program and making broad policy decisions. This advisory board is expected to include a representative of the Committee on Research of the Council of Pharmacy and Chemistry of the American Medical Association and also of the American Heart Association.

A central staff with headquarters in

Chicago will include a clinician and biostatistician who will coordinate the activities of the project and provide administrative and biostatistical services for participating investigators. A technical committee, composed of one representative from each of the hospitals and clinical research laboratories collaborating in the program, will serve as a means of constant communication between the various research teams and will determine the details of research procedure.

## Fire at Hungarian Museum

According to a refugee from Budapest, the Hungarian National Museum was largely burned during the recent revolution. The following groups of specimens were completely destroyed: mollusks, Acarina, Orthoptera, neuropteroid insects, Diptera, fishes, amphibians, reptiles, birds, and large mammal skeletons. The famous Horvath Heteroptera collection was partly destroyed. Coleoptera and Lepidoptera were largely undamaged.

## ACS Dexter Award

The Division of History of Chemistry of the American Chemical Society is asking for nominees to be considered for the 1957 Dexter award in the history of chemistry, which is administered by the division. The award will be made on the basis of services that have advanced the history of chemistry in any of the following ways: by publication of an important book or article; by the furtherance of the teaching of the history of chemistry; by significant contributions to the bibliography of the history of chemistry; or by meritorious services over a long period of time which have resulted in the advancement of the history of chemistry. All pertinent information concerning nominees should be sent *before 10 Mar.* to the secretary of the division, Sidney M. Edelstein, Dexter Chemical Corporation, 819 Edgewater Rd., New York 59, N.Y.

## NBC Educational TV Programs

All 22 noncommercial educational television stations in this country have agreed to present three series of programs on mathematics, music, and American government. They will be produced by the National Broadcasting Company.

The programs, which begin in March, will be transmitted live from New York to the educational stations over N.B.C.'s regular network facilities. Stations that are unable to televise the programs live will resort to kinescope film recordings.

N.B.C. has established a budget of more than \$300,000 to produce and feed programs to the educational TV stations.

The series on mathematics will feature lectures by college professors and other specialists. Five of the people who have already agreed to lecture on mathematics are Claude E. Shannon of Bell Telephone Laboratories, Inc., Morris Kline of New York University, Allen V. Astin of the National Bureau of Standards, Mina S. Rees of Hunter College, and Ernest Nagel of Columbia University. James Newman, author of *The World of Mathematics*, will supervise, design, and participate in the mathematics programs.

### High-School Physics in an Industrial Community

The proceedings of the Conference on the Need for High School Physics in an Industrial Community, edited by W. C. Kelly, may now be obtained for a small charge from the University of Pittsburgh Press. This timely conference, which took place last January, was jointly sponsored by the University of Pittsburgh and the National Academy of Sciences-National Research Council.

### Nearly 3 Million Students Enrolled

Some 2,947,000 students enrolled last fall in 1852 institutions of higher education, according to the annual fall enrollment survey of the Office of Education, Department of Health, Education, and Welfare. Additional enrollments during the school year are expected to bring the total to approximately 3 1/4 million, an all-time high.

The ten institutions reporting the largest enrollments this year are as follows: University of California, all campuses, but excluding extension enrollment, 40,788; University of Minnesota, all campuses, 36,303; New York University, 31,203; City College of New York, 28,178; State University of New York, all campuses, but excluding the agricultural and technical institutes, 27,566; Columbia University, 26,966; University of Illinois, 26,741; University of Michigan, 25,153; University of Wisconsin, all campuses, 24,442; and Ohio State University, 22,470.

College enrollments increased for the fifth consecutive year, the survey showed. There were 39.2 percent more students enrolled than in 1951. Enrollment figures were 10 percent higher this year than last year, the previous high. Nearly two-thirds (1,928,000) of the total number of students were men.

Total opening enrollment in separately organized professional schools (other

than teachers colleges and technological and theological schools) gained 19.3 percent over 1955. Teachers colleges enrolled 13.5 percent more than in 1955; technological schools, 13.4 percent more; junior colleges, 12.7 percent more; liberal arts colleges, 9.6 percent more; universities, 8.5 percent more; and theological schools, 2.3 percent more.

The number of students who enrolled for the first time in a college or university was a record 723,000. This was 7.1 percent above first-time enrollment in 1955 and 53.2 percent more than in 1951. The greatest increase in first-time opening enrollments was in junior colleges, with a gain of 16.5 percent over 1955. Increases also were reported for technical schools, 14.4 percent; "other professional schools," 9.6 percent; universities, 6 percent; teachers colleges, 4.1 percent; and liberal arts colleges, 2.3 percent.

Although relatively few women enroll in technical schools, their number increased 41.5 percent over 1955. A decrease of 5.5 percent in first-time students was reported by theological schools.

Total enrollment in higher education was about one-third more in Nevada (gain of 34.1 percent) than in 1955. Other states with large increases included South Dakota, 21.7 percent; Maine and New Mexico, each 19.9 percent; and Rhode Island, 19.2 percent. Nevada reported a 63-percent increase in first-time enrollment. Large gains were also reported for South Dakota, 22.4 percent; Indiana, 20.4 percent; California, 18.5 percent; and Oklahoma, 16.1 percent.

First-time enrollment declined 2 percent or more in New York (6.4 percent), Oregon (3.6 percent), Wisconsin (2.7 percent), Rhode Island (2.1 percent), and Florida (2 percent). The survey findings are reported in the January 1957 issue of *Higher Education* and in Office of Education Circular No. 496, *Opening (Fall) Enrollment in Higher Educational Institutions 1956*.

### Cornell Aeronautical's Wind Tunnel

The 1000-mile-an-hour wind tunnel at Cornell Aeronautical Laboratory has resumed test operations following a 5-month, \$2,225,000 modification program. The 32,000-horsepower tunnel is capable of testing aircraft, missiles, and propellers at speeds up to 1.3 times the speed of sound and at varying pressures (from 1/6 to 2 1/2 atmospheres). The tunnel's new 8- by 8-foot test section has perforated walls that permit accurate performance measurement on models at transonic speeds.

Automatic data-recording and com-

puting equipment has been set up at the laboratory, so that now test data can be processed within minutes after measurements are taken on a model in the wind tunnel, an operation that previously required up to 48 hours.

### Dental Association Survey

The American Council on Education this spring will begin a survey of dentistry in the United States at the request of the American Dental Association. The project will extend over 2 years and will cost \$400,000. The objective of the program is to assess the achievements, resources, and potentialities of dentistry in the United States; to determine desirable areas of future development; and to recommend methods for the better provision of service. The work will be supported by grants from the Kellogg Foundation, the American Dental Association, the Rockefeller Brothers Fund, and the Louis W. and Maud Hill Family Foundation.

The survey will center on four areas—dental education, dental research, dental practice, and dental health. A national commission, composed of representatives of such groups as education, management, labor, medicine, and dentistry, is being appointed by the American Council on Education to conduct and administer the program.

### Master's Degree Courses for High-School Physics Teachers

A conference on physics in education was held in New York last summer under the joint sponsorship of the Fund for the Advancement of Education, the American Institute of Physics, and the American Association of Physics Teachers. The major part of the discussion was devoted to providing more and better physics teaching at the secondary-school level. As one of its conclusions, the conference adopted the following resolution:

"WHEREAS the present situation of the physical sciences demands the attention and active support of the scientists in the college and university departments, and WHEREAS in the past those in the college and university departments have not fully cooperated with other groups in alleviating the difficulties

BE IT RESOLVED that the colleges and universities be urged to strengthen the program in the high schools by encouraging teachers in the secondary schools to take specially designed courses in physics which will bring to them the newer developments in physics and enable them to review the basic concepts and principles of physics. To bring the



teachers into such physics classes it is recommended that the courses be organized at the level of the teacher's preparation and with his needs in mind; that arrangements be made with the Graduate Schools and Departments of Education which will permit the use of credit in these courses toward the master's degree in Education. The courses should be taught by members of the departments of physics and should receive the active sponsorship of those departments."

### Duke's Engineering Program

Duke University will inaugurate new programs of graduate study in civil and mechanical engineering next fall. The additional courses will augment graduate study courses in electrical engineering that were added last September. The new graduate engineering programs in the College of Engineering will each lead to the master of science degree.

### Scientists in the News

EDGAR ANDERSON, Engelmänn professor of botany at Washington University (St. Louis) and director of the Missouri Botanical Garden, has become curator of useful plants at the garden. A grant of \$14,000 from the Guggenheim Foundation will allow him to explore the possibilities of extending his techniques for the measurement of variation to various kinds of organisms and various kinds of problems. Until April, he is the guest of the mathematics department at Princeton University, where he is working with John Tukey.

CLAUDIO ALVAREZ-TOSTADO, professor of physical sciences at Stanford University, is spending the current academic year on the faculty of the University of San Andres in La Paz, Bolivia, as a visiting professor of chemistry. His stay with the South American institution is being financed by the Department of State's International Educational Exchange Program.

HANS KRAESSIG, a German cellulose chemist who was associated for several years with Nobel laureate Herman Staudinger at the University of Freiburg, will head the new department of cellulose research at Industrial Cellulose Research Limited, Montreal, Canada, a subsidiary of the Canadian International Paper Company.

JOHN H. GAETH, former director of the Hearing Clinic at Northwestern University, has been named professor of speech and director of the Hearing Clinic at Wayne State University.

SAUL WINSTEIN, professor of chemistry at the University of California, is the Baker lecturer in chemistry at Cornell University for the spring term. He is lecturing twice weekly on "Neighboring groups, solvolysis, and rearrangement."

ROBERT C. JAMES, associate professor of mathematics at Haverford College, has been named professor and chairman of the mathematics department of Harvey Mudd College, Claremont, Calif. Coauthor with his father, Glenn James, of *A Mathematics Dictionary*, James has participated in studies administered by the Ford Foundation to discover ways of teaching college mathematics to selected high-school students. His research has included investigation of the implications of the existence of bases for Banach spaces.

IRVIN W. SIZER has been appointed head of the department of biology at the Massachusetts Institute of Technology. Sizer, who has taught physiology and biochemistry at M.I.T. since 1935, had been serving as executive officer and acting head of the department. He is well known for his studies of the fundamental properties and medical applications of enzymes.

F. W. SCHUELER has been appointed professor and chairman of the department of pharmacology at the Tulane University School of Medicine.

LLOYD J. ROTH has been named chairman of the department of pharmacology at the University of Chicago. He succeeds EUGENE M. K. GEILING, Frank P. Hixon distinguished service professor, who is retiring after 20 years as head of the department.

ARTHUR E. RUARK, Temerson distinguished service professor of physics at the University of Alabama, has been named chief of the controlled thermonuclear branch in the Division of Research, U.S. Atomic Energy Commission. He will administer the research program that is known as "Project Sherwood." He succeeds AMASA S. BISHOP, who recently became the commission's technical representative of the American Embassy in Paris.

Another AEC appointment is that of PAUL C. FINE as director of the Office of Operations Analysis and Planning. This office, which is a division of the general manager's office, is responsible for engineering and economic analysis of major technical programs and for coordinating long-range plans. Last year Fine, who joined the AEC staff in 1947, served as assistant to the late John von Neumann.

THOMAS H. PIGFORD, associate professor of nuclear and chemical engineering at Massachusetts Institute of Technology, has joined the General Dynamics Corporation's General Atomic Division. He will be chairman of the department of reactor engineering of General Atomic's John Jay Hopkins Laboratory for Pure and Applied Science. Though he has specialized in the nuclear, mechanical, and chemical design of power reactors, Pigford also has worked in the fields of isotope separation, purification of special reactor materials, and reprocessing of irradiated nuclear fuels.

The Kresge-Hooker Science Library Associates and the department of chemistry at Wayne State University have announced the spring schedule for the Frontiers in Chemistry lecture series. The following guests will lecture at 7:15 p.m. in the Kresge Science Library Building (Detroit).

25 Feb., T. S. WHEELER, University College, Dublin, Ireland, "Unsolved problems in flavonoid chemistry"; 11 Mar., THOMAS SINGER, Edsel B. Ford Institute for Medical Research, Detroit, Mich., "Metal-flavoprotein catalysis"; 18 Mar., STANLEY BRUCKENSTEIN, University of Minnesota, Minneapolis, Minn., "Acid-base reactions in glacial acetic acid"; 22 Mar., E. R. H. JONES, Oxford University, Oxford, England, "Some aspects of allene chemistry"; 1 Apr., D. H. R. BARTON, University of Glasgow, Glasgow, Scotland, "Some recent advances in the chemistry of sesquiterpene lactones"; 15 Apr., MILTON BURTON, University of Notre Dame, Notre Dame, Ind., "Radiation Chemistry"; 29 Apr., MICHAEL J. S. DEWAR, Queen Mary College, University of London, London, England, "Aromatic substitution"; 6 May, RONALD S. NYHOLM, University College, London, England, subject to be announced.

HANS H. WEBER, director of the Institute of Physiology in the Max Planck Institute for Medical Research, Heidelberg, Germany, will deliver three lectures on "The motility of muscle and cells" in New York next month under the sponsorship of the Muscular Dystrophy Associations of America, Inc. The lectures have been scheduled as follows: 4 Mar., 5 p.m., Columbia Medical Center, "The phenomena and conditions in the interior of the muscle fiber during contraction and relaxation"; 6 Mar., 4 p.m., Rockefeller Institute for Medical Research, "Facts and theories concerning the mechanism of the contraction phase of the muscle"; 8 Mar., 5 p.m., New York University Washington Square Center, "The four mechanisms involved in the movement of cells."

The following men have joined the staff of the year-old department of scientific research at Convair Division of General Dynamics Corporation, San Diego, Calif.:

JOHN E. NAUGLE, formerly of the University of Minnesota, senior staff scientist in physics; ORLO MYERS, formerly of the Stanford Research Institute, senior staff scientist in chemistry; HAROLD A. PAPAIZIAN, formerly of the Raytheon Manufacturing Company, staff scientist in physical chemistry; EUGENE J. PUTZER, formerly of Macalester College, staff scientist in mathematics; and ROBERT J. GOOD, formerly of the University of Cincinnati, staff scientist in chemistry.

MINOR I. HUGHES, formerly senior staff engineer and project leader in the Franklin Institute Laboratories, Philadelphia, Pa., has been named chief of the laboratories' machine development section. He succeeds WILLIAM W. DICKHART, III, who resigned to work with another organization. In his new position, Hughes will plan, direct, and coordinate projects requiring research, design, and development of machines and machine components.

B. D. THOMAS has succeeded CLYDE WILLIAMS, president of Battelle Memorial Institute, Columbus, Ohio, as director of Battelle's extensive research operations in the United States and Europe. Thomas, who is vice president of Battelle, has been a member of the institute's executive and technical staff since 1934.

JOHN H. EISEMAN of the gas chemistry section of the National Bureau of Standards has been given the Award of Merit of the operating section of the American Gas Association. Eiseman's work at NBS centers around research on the physical and chemical properties of fuel gases. Much of this work has been in association with the American Gas Association, with whom the bureau has cooperated for more than 30 years.

PAUL A. LEMBCKE, associate professor at the Johns Hopkins University School of Hygiene and Public Health, recently returned from Manila, where he was visiting professor of both epidemiology and hospital administration at the Institute of Hygiene, University of the Philippines. During his visit, which was supported by the World Health Organization and the Rockefeller Foundation, Lembcke surveyed the government hospital system and the teaching of public health, investigated an apparently new disease, Philippine hemorrhagic fever, and examined health conditions in the remote Sulu Archipelago.

FRANÇOIS N. FRENKIEL, member of the principal staff of the Johns Hopkins University Applied Physics Laboratory, Silver Spring, Md., has been appointed consultant to the Applied Mathematics Laboratory of the David Taylor Model Basin, Washington, D.C. He will continue a part-time association with the Applied Physics Laboratory, which is sponsoring a new series of monographs on applied mathematics and mechanics under his editorship.

HOWARD A. ROBINSON has been named chairman of the physics department at Adelphi College. He replaces ALBERT C. KRUEGER, chairman since 1949, who is leaving to enter industry. The new department head joins Adelphi after having served since 1952 as first secretary of the United States Embassy in France and as special assistant on scientific matters to the U.S. Ambassador.

HERBERT J. DUTTON, head of the Forage and Agricultural Residues Section of the Northern Utilization Research Branch, Agricultural Research Service, U.S. Department of Agriculture, Peoria, Ill., has won first award of \$1000 and an honor plaque in the 1956 glycerine research award contest of the Glycerine Producers' Association. The association makes these awards annually in recognition of new and independent research contributing to knowledge and use of glycerine. Dutton's award-winning accomplishment was the application of a recently developed extraction technique to investigate complex natural glycerides such as linseed oil.

DONALD B. ZILVERSMIT, professor of physiology at the University of Tennessee Medical Units in Memphis, won the second award (\$300 and an honor plaque) for his use of glycerine as a suspension medium in preparing high-caloric fat emulsions for intravenous injection.

STANLEY G. KNIGHT, professor of bacteriology at the University of Wisconsin, received the third award (\$200 and an honor plaque) for his research establishing a glycerine derivative, triacetin, as a new fungicide.

J. H. McLEOD, dean of the University of Tennessee College of Agriculture, retired from the university on 29 Jan. He was succeeded by WEBSTER PENDERGRASS, agronomy specialist at Tennessee.

D. A. WORCESTER retired from the department of educational psychology and measurements at the University of Nebraska on 1 Feb. He has accepted an appointment as visiting professor at the University of Wisconsin.

F. J. REITHEL has been appointed professor and head of the department of chemistry at the University of Oregon, Eugene. In the same department, TERRELL HILL has been appointed professor of chemistry. He will transfer from the Naval Medical Research Institute on about 1 July.

CHARLES N. MOORE, professor emeritus of mathematics and fellow in the University of Cincinnati's Graduate School of Arts and Sciences, has been appointed visiting professor of mathematics at the University of South Carolina, Columbia.

J. ROBERT OPPENHEIMER, director of the Institute for Advanced Study at Princeton, N.J., has received the Drexel Institute's annual science and engineering award. He was cited for his "major contributions in the field of theoretical physics and in the organization and administration of scientific research . . . and in appreciation of the challenge given the world to use science in a spirit of benevolence for the betterment—not the destruction—of mankind."

VICTOR H. HAAS, microbiologist and director of the National Institute of Allergy and Infectious Diseases, Bethesda, Md., since 1948, will return to laboratory research at that institute. He will be succeeded by JUSTIN M. ANDREWS, now associate chief of programs in the Public Health Service's Bureau of State Services. The changes will become effective in April.

## Recent Deaths

FRED R. BEAUDETTE, New Brunswick, N.J.; 59; professor of animal pathology at the College of Agriculture, Rutgers University; 16 Jan.

DION K. DEAN, Rahway, N.J.; 72; former head of the industrial division of the Foster Wheeler Corporation; 7 Feb.

RAYMOND E. KIRK, Brooklyn, N.Y.; 66; dean of the graduate school of the Polytechnic Institute of Brooklyn; 6 Feb.

DOUGLAS D. R. MacCALMAN, London, England; 53; professor of psychiatry at Leeds University; 31 Jan.

ISADOR RIPPS, Plainfield, N.J.; 54; assistant professor of clinical medicine at New York University-Bellevue Medical Center; 17 Jan.

W. HENRY RIVARD, Providence, R.I.; 73; dean of the Rhode Island College of Pharmacy; 5 Feb.

ALBERT C. SCHAEFFER, Madison, Wis.; 49; professor of mathematics and chairman of the department at the University of Wisconsin; 2 Feb.

## Reports

### Immunization against *Trypanosoma lewisi* in Rats by Injections of Metabolic Products

The early cessation of reproduction that is characteristic of *Trypanosoma lewisi* infections in rats was recognized by Taliaferro (1) to be due to an antibody, ablastin, which he and others considered distinct from the trypanocidal antibodies that are believed to be responsible for the number crisis and for ultimate eradication. Subsequently a third, agglutinating, antibody was postulated (2). Serum containing ablastin, passively transferred, inhibits reproduction and is therefore protective. It is not absorbed by the parasites, does not sensitize them, and does not physically injure them, for they reproduce normally when washed and transferred to a nonimmune host.

We felt that ablastin might well be an antibody directed against metabolic products (secretions or excretions or both) of the parasites, as one of us (3) previously suggested. To test this hypothesis, we attempted to immunize rats by injection of trypanosome-free metabolic products. Blood containing numerous dividing trypanosomes was obtained by aseptic heart puncture of rats before any demonstrable ablastin had formed. The trypanosomes were separated by centrifugation, washed with saline, suspended in equal parts of normal rat serum and saline so that there were about 200 million parasites per milliliter of medium, and incubated for 24 hours at about 27.5°C. With addition of 0.0025 g of glucose per milliliter after about 12 hours, they remained actively motile for the entire 24 hours. After incubation, the majority of the trypanosomes were separated by centrifugation, and the supernatant, containing the met-

abolic products of the parasites, was filtered through fritted glass (fine porosity) and stored in a deep freezer until ready for use. No deformed or disintegrating trypanosomes, and very few nonmotile ones, were seen among thousands that were examined and counted after incubation, and there was no decrease in numbers; care was taken not to crush any of the parasites during filtration. The separated trypanosomes were then washed in saline and triturated by repeated freezing and thawing until test inoculations showed that no infective organisms were left.

Six 100-g rats were each given six intraperitoneal injections, at 3-day intervals, with metabolic products from a total of 4000 million trypanosomes, approximately the number present in a 100-g rat at the height of an infection, and six others were each similarly injected with the triturated bodies of the 4000 million trypanosomes from which the metabolic products had been obtained; six controls were given injections with normal serum and saline, and six others were not injected. On the tenth to 12th day after the last injection all rats were inoculated intraperitoneally with 50,000 washed adult trypanosomes, after which daily blood examinations were made.

All the rats in the control groups had typical infections reaching peaks of from about 200,000 to 600,000 trypanosomes per cubic millimeter. Of the rats injected with trypanosome bodies, all became positive in the normal time; five had low peaks of from less than 500 to 7500/mm<sup>3</sup> and became negative after the fifth to 11th days, and one reached a peak of 200,000/mm<sup>3</sup> for 1 day and became negative after the 16th day. The six rats injected with metabolic products remained completely negative throughout.

Six additional rats were given six injections with the metabolic products of a total of 2000 million trypanosomes and, with three controls, were inoculated with 20 million trypanosomes 10 days after the last injection. In the control rats, the blood became positive within 1 hour, and the infections ran a normal course, but in the injected rats again there was complete protection, since no trypanosomes were ever seen in the blood smears.

Using wetted slides, we added adult

trypanosomes to a few drops of serum from each of the following: (i) normal rats; (ii) rats that had been "immunized" with triturated trypanosome bodies; (iii) rats that had been "immunized" with metabolic products; and (iv) rats that had recovered (the serum was taken 6 weeks after infection). Observations were made at intervals of a few minutes to 1 hour for 6 hours. The parasites in the serum from group i, diluted 1/3, remained active and unagglutinated throughout. Those in the serum from group ii, diluted 1/3, showed a slight degree of agglutination at 15 and 30 minutes, but by 45 minutes the parasites in the few small clumps were dispersing, and after 1 hour they were unagglutinated and normal in appearance and motility. In contrast, in the serum from group iii, agglutination began within 5 minutes in serums diluted 1/1 to 1/5, and in 10 minutes in serums diluted 1/10, 1/25, and 1/100. Up to a dilution of 1/5, practically all the parasites became agglutinated in large clumps within 10 or 15 minutes, and in dilutions up to 1/100 somewhat later. Slight agglutination occurred at a dilution of 1/200, but none at 1/400 or above. In all cases agglutination was accompanied by a marked loss of swimming activity, but motility continued. In the serum from group iv, the results were identical with those in group iii at dilutions up to 1/10, but at 1/100 the effect was somewhat weaker; the agglutination was not as complete or in as large clumps. In a test with serum from group iii collected 6½ months after the last immunizing injection, there was some loss of titer, but the 1/1 serum had lost none of its potency.

Preliminary absorption experiments with immune serum from recovered rats indicate that absorption with lyophilized metabolic products markedly reduces the protective power of the serum and permits practically normal reproduction when administered to rats at the rate of 1 ml/100 g 1 hour prior to intraperitoneal injection of 20 million adult trypanosomes. In contrast, immune serum absorbed with trypanosome body substance loses little if any of its protective power and, as when unabsorbed serum is used, no dividing forms are found. This indicates that the antimetabolic-products antibody must be regarded as ablastin, even though the rapid destruction of trypanosomes in the presence of adequate amounts of the antibody has prevented direct demonstration of inhibition of reproduction.

Our results indicate that agglutination and reduced locomotion, some of the effects hitherto attributed to trypanocidal or other antibodies (2, 4), and which render the parasites more susceptible to being filtered out of the blood and phagocytized, are really produced by ablastin.

All technical papers and comments on them are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table or one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in *Science* 125, 16 (4 Jan. 1957).



These phenomena may be the result of antibody combination with excreted metabolic products adhering to the surface of the trypanosome bodies. Further work on the protective power of antimetabolic products serum, with or without absorption, is in progress.

It is probable that ablastin acts specifically against an enzyme or enzymes concerned in the nutrition of the parasites, as was postulated by one of us (3, 5) when the similarity between inhibition of reproduction of *Trypanosoma lewisi* and the interference with growth, development, and reproduction of the nematode *Nippostrongylus muris* was pointed out.

We believe that this production of functional immunity through the agency of antibodies directed against metabolic products, which interferes with nutrition, will be found to be a widespread phenomenon among infectious organisms (6).

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ASA C. CHANDLER

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6. This work was supported by a research grant from the National Institutes of Health.

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1 October 1956

### Chromatographic Microassay for Cholesterol and Cholesterol Esters

Free cholesterol is readily separated from its esters by column chromatography on silicic acid. The separation is quantitative, and the two components can then be assayed separately. The procedure described here (1) requires relatively small samples and can be completed in less than 1 hour. With a simple modification of the extraction procedure, it is possible to get a reliable assay using only 0.02 ml of human plasma or 0.05 ml of rat plasma. The 100-mesh silicic acid sold by Malinkrodt especially for chromatography is satisfactory for this purpose. Ordinary reagent-grade products may be activated by heating them at 120°C overnight (2) and then quickly sieving them once in a moist atmosphere. The activated silicic acid must be protected from atmospheric moisture.

For quantitative assay, we use a chromatographic tube made of 8-mm (outside diameter) glass tubing about 25 cm long. The tube is abruptly constricted on one end to a diameter of 2 to 3 mm

inside, and the end is drawn out about 10 mm to form a short nipple. To prepare the column, ram a small pledget of cotton down the tube to plug the constricted end. Fill the tube to a height of about 5 cm with silicic acid by means of an eye dropper and pack it by applying air at a pressure of 7 to 10 lb/in.<sup>2</sup> to the top of the column. Prewet the column by forcing through about 2 ml of petroleum ether by means of the same air pressure.

For the routine assay of human plasma or serum, our procedure is as follows. Mix 0.1 ml of plasma or serum with 5 to 7 ml of 1/1 methanol and acetone. Bring the mixture to boiling, cool, dilute to 10 ml with solvent, and filter. Evaporate a 3.0-ml aliquot by placing the tube in cold water and bringing the water to boiling. Invert the tube while it is cooling to drain out the residual vapor of the solvent. Transfer the lipid to the column with three 2-ml portions of petroleum ether (boiling range 30° to 60°C) by means of an eye dropper.

Rinse the test tube and the chromatographic tube with each portion of solvent and force each through in turn. The flow rate should never be greater than 4 ml/min with any of the solvents. Care should also be taken never to allow the solvent level to go below the top of the silicic acid in this step and in the next one. At this point the free and esterified cholesterol are adsorbed at the top of the column. (This may be demonstrated by extruding the column by means of air pressure gently applied to the bottom of the tube and streaking it with concentrated sulfuric acid.)

Develop the column with about 4 ml of 1/1 chloroform and petroleum ether. Collect this eluate, which contains the esterified cholesterol, in a separate test tube. Rinse the outside of the tip of the chromatographic tube with about 1 ml of petroleum ether, allowing the ether to run into the same test tube. To remove the free cholesterol from the column, elute with 4 ml of 1/1 methyl or ethyl acetate and petroleum ether. Force this through until flow ceases, and rinse the tip as before. Extrude the column by means of air pressure as described in the preceding paragraph and discard the silicic acid.

Evaporate the solvents in the aforementioned manner and take the fractions up in 3.0 ml of glacial acetic acid. Warm the tubes containing the esters to effect solution. Cool and add 2.0 ml of the ferric chloride-sulfuric acid reagent of Brown *et al.* (3) and mix thoroughly. Read the optical density at 560 mμ in the Coleman universal spectrophotometer. For precise work, it is necessary to prepare chromatographed solvent blanks. The standard contains 50 μg of cholesterol in 3.0 ml of acetic acid, and

Table 1. Estimation of free and stearyl cholesterol in mixtures containing different amounts.

Mixture of free and stearyl cholesterol chromatographed (mg of each)	Stearate found		Free cholesterol found	
	(mg)	(%)	(mg)	(%)
2.00	2.07	103.5	2.07	103.5
0.200	0.207	103.5	0.201	100.5
0.020	0.0201	100.5	0.0199	99.5

the blank for this is not chromatographed. The color develops rapidly and is stable for hours. With rat plasma or serum, an 8-ml aliquot of the methanol-acetone extract is required for a satisfactory reading of optical density.

This procedure separates plasma cholesterol into its free and esterified fractions. If a plasma extract, or a mixture of cholesterol and its stearate, is placed on the column and the development with chloroform and petroleum ether is continued beyond the usual amount, it is found that the first two milliliters of eluate contain a large amount of cholesterol. This is esterified cholesterol. The third milliliter of eluate contains only a trace of cholesterol, and the fourth to about the tenth milliliters have none. As the development is continued beyond the tenth milliliter, the free cholesterol appears in the eluate. It is all eluted after about 20 ml of chloroform and petroleum ether have been used.

In Table 1 we see that the column will function satisfactorily over a very wide range of cholesterol or cholesterol stearate concentration. In Table 2, evidence is presented that free cholesterol or its stearate added to an extract of plasma can be quantitatively demonstrated. Rat adrenal cholesterol is assayed by extracting the macerated gland in a hot mixture of methanol and ace-

Table 2. Recovery of free and of stearyl cholesterol which were added to plasma extract. The amounts added and found are given in milligrams per 100 ml of plasma.

Compound	Amount		Recovery (%)
	Added	Found	
Stearyl cholesterol	150	151	101
Free cholesterol	100	104	104

tone, evaporating a suitable aliquot, and chromatographing in the same manner. However, since the free cholesterol in the adrenal gland is relatively very low, one must use a large aliquot and dilute the ester fraction after chromatography if the free cholesterol level is desired.

Although the ester fraction can be determined by using the method of Brown *et al.* (3), the free adrenal cholesterol is accompanied by turbidity, which interferes slightly with this method. Turbidity is not observed with a modified Lieberman-Burchard procedure. Because of its sensitivity, the modified Tschugaeff reaction of Hanel and Dam (4) may be better suited to the determination of free cholesterol in adrenal tissue after chromatography on silicic acid.

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21 December 1956

### Actions of d-Lysergic Acid Diethylamide and Its 2-Bromo Derivative on Heart of *Venus mercenaria*

Physiological evidence indicates that the inhibitor nerves of the heart of the mollusk, *Venus mercenaria*, are cholinergic in nature (1), and that the activity of the excitator nerves is mediated by 5-hydroxytryptamine (5-HT, serotonin) (2). d-Lysergic acid diethylamide (LSD) was found to be an antagonist of serotonin on certain mollusk hearts under the conditions of the experiments (3). An early report that LSD was an effective antagonist on the *Venus* heart was later modified (4) when it became clear that LSD had a marked excitator action on this heart. This action persisted for long periods of washing during which a maximum amplitude of beat obscured the action of large doses of serotonin. It was stated that on the *Venus* heart, LSD acts as an essentially irreversible analog of serotonin (4). Recently, Shaw and Woolley (5) confirmed this observation.

The importance of a proper understanding of the fundamental mode of action of LSD prompts us to report fur-

ther our earlier studies with LSD and our more recent observations of the action of 2-bromo-lysergic acid diethylamide (Bol-148, bromo-LSD) on the *Venus* heart (6). At a concentration of  $10^{-6}M$ , both serotonin and LSD produce a nearly maximal increase in amplitude in less than 10 minutes. After a heart has been washed for a few minutes, it recovers from serotonin; but after many hours of washing a heart that has been treated with LSD may still be greatly excited. No way has yet been found, including washing at a high pH, to restore quickly an LSD-excited heart. At concentrations below  $10^{-9}M$ , serotonin seldom excites the isolated *Venus* heart. If hearts are allowed to remain in a 10-ml bath of  $10^{-10}M$  LSD, they are maximally excited in 1.5 to 2 hours. At a  $10^{-16}M$  concentration of LSD, up to 3 hours may be required for the heart to adsorb an amount of LSD that produces near maximal excitation. Axelrod *et al.* (7), from studies of tissue distribution, calculate that LSD exerts its characteristic effect in man at a level of 0.0003  $\mu g/g$  of brain tissue. The *Venus* heart responds maximally at a tissue concentration that must be below this, for 10 ml of  $10^{-16}M$  LSD contains only 602,000 molecules.

An important problem not yet resolved is whether the "LSD psychosis" results from central blocking of serotonin, or from a serotoninlike action of LSD, or for other reasons. 2-Bromo-lysergic acid diethylamide may prove useful in helping to solve this problem. Cerletti and Rothlin (8) found bromo-LSD to be a more effective antagonist of serotonin than LSD at a number of sites in mammals. This blocking action was highly specific, and they saw no signs of antihistamine, antiadrenaline or antiacetylcholine action. Certain of these observations have been amply confirmed and extended (9). Cerletti and Rothlin, however, failed to find any indication of an abnormal psychic disturbance produced by doses of bromo-LSD even 20 times as great as effective doses of LSD. They concluded that their results with bromo-LSD make it difficult to correlate the psychic effects of LSD with its antiserotonin property. The interesting observation has now been made by Ginzel and Mayer-Gross (10) that bromo-LSD, when it is administered 1 or 2 days before LSD, abolishes or greatly reduces the LSD psychosis without, by itself, having significant central action even in 2- to 3-mg amounts.

On the *Venus* heart, bromo-LSD is an effective antagonist of serotonin. On some hearts, high concentrations ( $10^{-4}$  to  $10^{-5}M$ ) have a weak stimulating action resembling that produced by LSD, while on others there is no apparent effect. However, after treatment of hearts with bromo-LSD in concentrations in the

range of  $10^{-4}$  to  $10^{-6}M$  for 1 hour or longer, the excitator action of a molar concentration of serotonin one-tenth as great is completely blocked. It is of further interest that previous exposure of a *Venus* heart to bromo-LSD abolishes or greatly reduces the excitator action of LSD that is subsequently applied. For example, on some hearts, pretreatment with  $10^{-4}M$  bromo-LSD may completely prevent the otherwise marked excitator action of  $10^{-6}M$  LSD.

Serotonin appears to be a normal regulatory neurohumor of the *Venus* heart. This heart is extremely sensitive to LSD, which has an excitator action resembling that of serotonin. Unlike serotonin, however, the action of LSD is very slowly reversed by washing. Bromo-LSD antagonizes the actions of both serotonin and LSD on the *Venus* heart. These several actions and interactions appear to parallel rather closely those seen in the mammalian central nervous system.

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13 September 1956

### Technique for Behavioral Analysis of Human Observing

The monitoring of a display (for example, a search radar) by human beings raises problems of considerable practical and theoretical interest. In general, the probability of detection of a signal varies directly with the signal rate; is a function of the temporal arrangement of the signals; and, in the case of low signal rates, varies inversely with the duration of the monitoring task. Such monitoring situations are badly in need of a descriptive behavioral analysis that would permit isolation of the variables which control the behavior underlying the probability of signal detection.



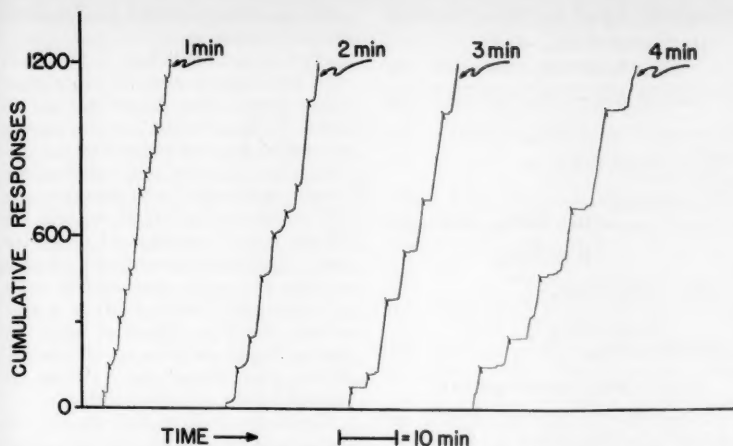


Fig. 1. Cumulative response records for 1-, 2-, 3-, and 4-minute fixed-interval schedules of pointer deflections. Detections are indicated by lines cutting across the records.

It is here assumed that a detection can result only after the operator has provided the responses of "looking at" or "orienting to" the display. In other words, certain responses, here called *observing* responses, must be made in order that a signal can be observed and reported.

The present study serves to illustrate (i) that the techniques employed in operant conditioning of animals (see Skinner, 1) can be useful in analyzing these observing responses and (ii) that the behavioral principles that have emerged from animal laboratories show promise of being rather directly applicable to the observing behavior of human beings. The proposed approach assumes that observing responses are controlled by detections of the signals for which the individual searches, and that this control is in the nature of reinforcement paralleling exactly the effect of food reinforcement upon operant responses that have been demonstrated with animals (2).

To pursue this analysis, human subjects were provided a task in which the observing response was easily recorded. Working in a dark room, they were required to observe and report deflections of a pointer on a dial that could be seen only after they had pressed a key which provided a brief flash of light, thereby illuminating the face of the dial. When the subject pressed the key (that is, emitted an observing response), the light flashed for a period of 0.07 sec, even if the subject held the key down. Thus, he had to release and repress the key to obtain another look at the dial. When he observed a pointer deflection, he reported it by pressing another key that reset the pointer. The pointer remained deflected until this key was pressed.

Each subject was instructed that his only aim should be to make as many de-

tectations as he could and to reset the pointer as rapidly as possible. At the end of each session, he was informed of the number of detections made and the average time per detection. He was not informed that the experimenter was in any way concerned with the frequency with which he flashed the light. Actually, however, cumulative response records were made of his responses on the light-flashing key.

Deflections of the pointer were scheduled in many different ways analogous to the scheduling of food reinforcement with animals. Several of these have been successfully used and have provided data closely paralleling those found with more conventional reinforcement.

The control exerted by the detections of the pointer deflections can be illustrated by what has been termed a fixed-interval schedule. On this schedule, the pointer deflection, (or reinforcement) would occur at some set period of time after the last deflection. Five navy enlisted men serving as subjects were placed on fixed-interval schedules beginning with a 1/2-minute interval, after which the interval was gradually increased in blocks of eight 40-minute sessions to 1 minute, 2 minutes, 3 minutes, and finally to 4 minutes.

The data from portions of cumulative response records for one subject at each interval are presented in Fig. 1. Each curve is a segment of the record from the last session which the subject had on the indicated interval. The curves are displaced along the horizontal axis. Each time the subject pressed the key that flashed the light (that is, emitted an observing response) the recorder pen moved a very small step upward while the paper moved slowly to the left. Thus the slope of the line provides a direct indication of the rate of observing re-

sponses. Flat portions, then, indicate periods of no observing responses. Reports of detections are marked by the lines cutting across the curves. It should be noticed that after each detection observing responses cease for a while; then, after some time has elapsed, responding resumes in an accelerated manner, providing a scallop-shaped record of the observing rate. These scalloped records are also characteristic of animals working for food reinforcement on fixed-interval schedules.

A further demonstration of the nature of the control exerted by detections can be seen by examining what happens to the observing response rate after no more pointer deflections occur (that is, during extinction). In Fig. 2 data are presented for the same subject reported in Fig. 1. However, the subject first received three pointer deflections on the 4-minute schedule on which his behavior had been maintained for eight sessions, and then no further pointer deflections occurred. Following the detections, the typical scalloped records are seen; when deflections no longer occur, the high rate of observing continues for a time and then rather rapidly drops off. Again this finding is analogous to that obtained by using food reinforcement on animals and demonstrates that the observing rate is controlled by the detection of the signal for which the observer searches.

These and other results suggest that a behavioral analysis is possible and that observing behavior is controlled by the detections in the same manner that instrumental responses in animals are controlled by food reinforcement. If so, the findings of classical attention studies,

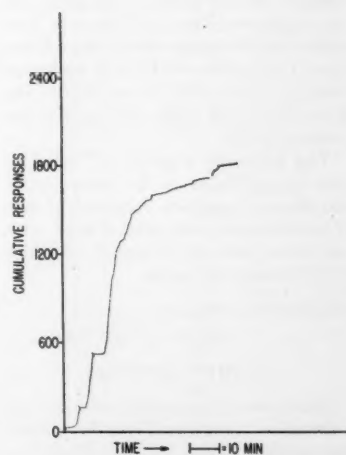


Fig. 2. Cumulative response record showing effect of withholding pointer deflections following fixed-interval schedule. After three detections (indicated by lines cutting across the record) no further pointer deflections occurred.

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allowed to stand overnight to insure complete reaction. Good results were obtained on known mixtures after a reaction time of only 2 hours.

Strips of Whatman No. 54 filter paper, 7½ by 18 in., were soaked in 0.05M phthalate buffer and allowed to dry. The strips were ruled with lines parallel to the long edges, the first 11/16 in., and then four at intervals of 1½ in. Of the four pathways so marked, three were used for samples and one was left as a blank. The samples were applied at spots 4 in. from the upper end of the strip, thus clearing the antisiphon rod that supported the paper in downward development. Each spot contained the amino acid from two or three 7.1-μl aliquots.

The chromatogram was developed for 18 hours by the descending method with t-amyl alcohol that had been equilibrated with the phthalate buffer. The chromatogram was covered with brown paper to minimize the losses of light-sensitive derivatives.

After development was complete, portions of the paper containing the spots were excised and transferred to 6-in. test tubes. Blanks were similarly cut from the appropriate track at the same distance from the starting line as the unknown. In order to insure standardization of the size of the piece of paper excised, a template was fashioned from a thin sheet of Plexiglas. Spots of the 2,4-dinitrophenol and 2,4-dinitroaniline were not excised. Four milliliters of water was pipetted into each tube, and the samples were allowed to stand for 2 hours in the dark with occasional agitation.

The extract was transferred to a 1-cm glass cell, and its absorbancy was taken against water in a Beckman DU spectrophotometer at 365 mμ with a slit width of 44 μ. The results appear in Table 1. Calculations were made from the following formulas:

$$\frac{(\text{Absorbancy}) (k)}{15.6} = \mu\text{moles/ml of eluate}$$

where  $k$  is an empirical constant for each amino acid determined by Levy,

$$\frac{(\mu\text{mole/ml}) (4 \text{ ml}) (1000/\text{ml}) (14.8 \text{ ml})}{\text{Number spotted}} = \mu\text{moles of acid}$$

$$\frac{(\mu\text{mole}) (\mu\text{g}/\mu\text{mole})}{\mu\text{g of amino acid in 200 ml of irradiated sample}}$$

Several chromatograms were run with 1.5M phosphate buffer as the developing solvent. This buffer is prepared by making a solution 1.0M in NaH<sub>2</sub>PO<sub>4</sub> and 0.5M in Na<sub>2</sub>HPO<sub>4</sub>. Development was allowed to proceed about 4 hours. The spots of the (unknown) diaminosuccinic acid and aspartic acid were excised and extracted, and the absorbancy was taken. Glycine did not separate from dinitro-

phenol. In this way, a partial check of the first results could be made.

Blank runs on ammonium acetate solutions that had not been exposed to β-radiation revealed no amino acids.

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3. For Eq. 3, see T. Rigg, G. Scholes, J. Weiss, *J. Chem. Soc.* 1952, 3034 (1952); for Eq. 4, see M. J. Day and G. Stein, *Nucleonics* 8, 37 (1951).
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13 November 1956

### Cholinesterase in the Nemertean

#### *Prostoma rubrum*

In conjunction with studies on various invertebrates collected in our vicinity, experiments were undertaken to determine the concentration of cholinesterase in the invertebrates. In the series of studies, it was found that the fresh-water nemertean *Prostoma rubrum* has a high concentration of cholinesterase in its body tissues. A more detailed study was made to determine whether "specific" or "non-specific" cholinesterase was present in the animals.

*Prostoma rubrum* was collected from Mill Pond, Tooele County, Utah, in October 1955 and 1956. This animal is found abundantly only during the fall. Large numbers of individuals were isolated and kept in white enameled pans and petri dishes in the laboratory. The animals measured up to 15 mm in length, and their average weight was 1.5 mg.

Assays for cholinesterase activity were performed on groups of 15 to 40 animals. The animals were rinsed in spring water, blotted dry with tissue paper, and weighed. They were then homogenized in physiological saline with a motor-driven Potter-Elvehjem homogenizer. The homogenates were diluted to a total volume of 10 ml and kept overnight in the cold room. They were assayed on the following day. Cholinesterase activity was determined by the titrimetric method. Acetylcholine bromide (ACh), acetyl-β-methylcholine chloride (MeCh), and butyrylcholine chloride (BuCh) were used as substrates for these assays, which were run at 25°C. Final substrate concentrations of 0.005M acetylcholine bromide, 0.01M acetyl-β-methylcholine

chloride, and 0.01M butyrylcholine chloride were used for these assays.

The results of these experiments are given in Table 1, where they are recorded in terms of cholinesterase activity ( $Q_{\text{ChE}}$  in milligrams of substrate hydrolyzed per 100 mg of tissue, per hour). Average cholinesterase activities of 712, 658, and 515 were obtained for homogenates of the first three groups of animals, the homogenates being kept in the cold room overnight, except the homogenate from the last group of animals, which was assayed immediately after it had been homogenized. Samples of these homogenates were kept in the cold room for 4 additional days and were subsequently assayed for cholinesterase activity. The stored homogenates showed a great increase in activity—the range at this time was from 899 to 676.

The results obtained by the titrimetric method were checked by the colorimetric method on homogenate that had been frozen for 2 months. The cholinesterase activity obtained by this method was 510, compared with an activity of 528 obtained by the titrimetric method.

Assays were performed on homogenates of three groups of animals to determine the presence or absence of specific and nonspecific cholinesterases in the nemertean. Aliquots of homogenates were assayed, and it was found that the average cholinesterase activities for these three groups were 525 (acetylcholine bromide substrate), 272 (acetyl-β-methylcholine substrate), and 125 (butyrylcholine substrate). These results show that both specific and nonspecific cholinesterases are present in *Prostoma rubrum*.

The occurrence of cholinesterases has

Table 1. Cholinesterase activity ( $Q_{\text{ChE}}$ ) in *Prostoma rubrum*. The substrates were acetylcholine bromide (ACh), acetyl-β-methylcholine chloride (MeCh), and butyrylcholine chloride (BuCh).

No. of animals	Total wt. (mg)	$Q_{\text{ChE}}$ (mg of substrate hydrolyzed/100 mg of tissue/hr)		
		ACh	MeCh	BuCh
20	29.4	712		
		899*		
20	34.6	658		
		776*		
40	51.4	515		
		676*		
20	34.2	582	282	123
15	18.6	539	263	
20	28.8	454	272	127
-	708.0	528		
-	708.0	510†		

\* Stored 5 days. † Colorimetric method (frozen 2 months).



been reported in invertebrates by various workers and has been reviewed by Augustinsson (1) and Prosser *et al.* (2). Prosser lists a cholinesterase activity of 16 to 17 for the body wall of the earthworm as the highest concentration of cholinesterase in invertebrate tissues. Nachmansohn, Coates, and Rothenberg (3) report a high cholinesterase activity of 461 for the extreme anterior end of the electric organ of *Electrophorus electricus*. An activity of 6.8 has been reported for a marine nemertean, *Cerebratulus lacteus* (4). In the present work with *Prostoma rubrum*, an activity of 454 to 899 is recorded. This is an extremely high concentration of cholinesterase, even higher than that reported for the electric eel.

It is interesting to note that there was a great increase in the acetylcholine hydrolyzing activity with the storage of the homogenates in the cold room for 5 days. Metcalf and March (5) reported an increase in activity of bee brain homogenates by storing them overnight after grinding. They explained this phenomenon as being caused by the greater breaking up of tissues and cells upon standing. Further work is being carried out to determine the effect of storage on the hydrolytic activity of the homogenates and the nature of the acetylcholine-splitting substance present in *Prostoma rubrum*.

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13 November 1956

### Limited Reliability of Precordial Electrodes as Vectorcardiographic Leads

A perplexing question in clinical vectorcardiography is whether lead systems employing relatively few precordial electrodes can accurately record the electric forces of the heart. An intensive study by Frank on a normal human subject apparently shows that precordial electrodes can record these forces accurately when the electrodes are properly located and weighted (1). However, clinical electro- and vectorcardiography is concerned with the abnormal, as well as the normal, state, one of the most important abnormalities being myocardial infarction. As

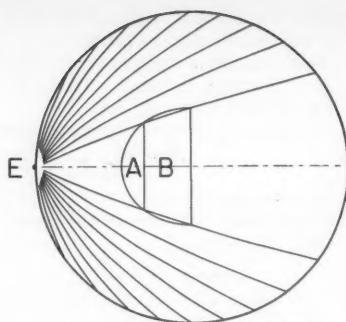


Fig. 1. Lead field (axially symmetric isoflow intervals) of a unipolar electrode, *E*, located on the surface of a homogeneous, spherical volume conductor. As is explained in the text, ablation of the apical segment, *A*, of the depolarization wave reduces the electrocardiographic output to zero, even though 45 percent of the original electric moment remains in the zonal region, *B*.

a result of studies on a mathematical model, we feel that precordial electrodes may be entirely unreliable for the accurate registration of heart vectors in cases of this kind.

In this study the body is represented as a homogeneous, spherical volume conductor, and the heart as a hemispheroidal depolarization wave front whose base center coincides with that of the sphere (Fig. 1). The hemispheroid contains a uniform distribution of normally oriented current doublets. A "precordial" electrode, *E*, is located at the intersection of the sphere and the axis of the depolarization front. The other electrocardiographic connection (not shown in Fig. 1) consists of numerous point electrodes uniformly applied to the model surface and connected to a common terminal by equal resistors of relatively large magnitude. This compound connection averages potentials of the body surface, serving therefore as an indifferent, or so-called "unipolar," connection. Its function is based on much the same principles as Bayley's spherical integrating electrode (2).

The curved lines emanating from *E* map the streamlines of the electric field that is produced in the model when current from an external source is from *E* to the compound electrode. The mapping procedure was based on an equation (3) derived from a consideration of a point-current source at *E* and its electric images (4). Since the streamlines were also plotted as axially symmetric isoflow intervals, the map represents the so-called "lead field" of the electrocardiographic connection. In accordance with lead-field theory (5), the electrocardiographic output of the model is directly proportional to the number of isoflow

intervals that the depolarization front occupies. Since the depolarization front in the illustration crosses one isoflow interval, it produces a relative electrocardiographic output of one unit. However, when the apical segment, *A*, of the depolarization front is ablated by "infarction," a dramatic alteration of the heart-lead relationship ensues.

Ablation of this segment reduces the electric moment of the depolarization wave to 45 percent of its original value without alteration of direction or sense. But because the remaining zonal portion, *B*, does not cross any isoflow intervals, the electrocardiographic output is reduced to zero.

This simple example, then, illustrates that although the precordial electrode adequately records the electric moment of the total depolarization front (6), it fails completely to record the electric moment that remains after the indicated ablation has occurred.

A more penetrating analysis of the disturbed heart-lead relationship is achieved by calculating the potential which zone *B* produces at various points along the equator of the model. The results of these computations, which were performed by means of Frank's formula (6), are illustrated in Fig. 2. According to this figure, the potential is zero at *E*, increases to a maximum at about 60 deg away from the axis of the depolarization front, then decreases progressively to a minimum value diametrically opposite *E*. Thus, in making one circuit of the equator, an exploring electrode passes through two maxima of equal potential and two minima of unequal potential. Since one of the minima is at zero potential, the exploring electrode passes through three points of zero potential. These results are considerably different from a dipolar distribution of potential (6), in which case the exploring electrode passes through only one maximum and one minimum, and through two points of zero potential. Actually, as far as the distribution of surface equipotentials is concerned, there does not appear to be any way of representing the electric activity of the truncated depolarization front as a single dipole.

It seems worthwhile to emphasize that zone *B*, although responsible for almost

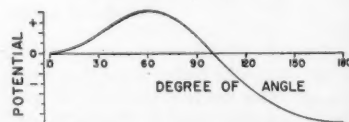


Fig. 2. Distribution of surface potentials due to the truncated depolarization wave, *B*, shown in Fig. 1. The curve shown here differs greatly from that of simple dipolar distribution and cannot be ascribed to a single equivalent cardiac dipole.



half of the total electric moment, is silent with respect to electrode *E*. In contrast, segment *A* contributes almost double its share to the electrocardiographic output. This augmentation effect is intimately related to the proximity of the apical segment to electrode *E* and tends to gain-say the contention (7) that precordial leads are not selectively influenced by local action currents.

This study strongly suggests that in myocardial infarction the distribution of electrocardiographic potentials on the surface of the body may not be at all equivalent to that of a single cardiac dipole. If this conclusion is supported by studies at a clinical level, it will cast serious doubt on the accuracy in infarction of vectorcardiographic systems that employ a limited number of body surface electrodes, particularly when the electrodes are in proximity to the infarcted area (8).

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20 December 1956

### Oral Incubation in Bahaman Jawfishes *Opisthognathus whitehursti* and *O. maxillosus*

Since known cases of oral incubation of eggs in marine fishes are limited to a very few families, and since we have been unable to locate any published records for the *Opisthognathidae*, it seems worth while to note the occurrence of this behavior in the jawfishes we have observed in the Bahamas.

In Nassau harbor between New Providence and Hog islands, there is a shallow area on the north side of the channel which has rather dense populations of the two species *Opisthognathus whitehursti* (Longley) and *O. maxillosus* Poey (1). The region inhabited by the jawfishes is largely of rock and white sand, with *Thalassia* beds along its inshore side, and with the urchin *Diadema* present in great numbers. There is a considerable current in the channel—so much that during tidal flow it is difficult to maintain one's position standing in waist-deep water.

On 12 May 1956 we were amassing a series of *O. maxillosus* for taxonomic study, for there is as yet some uncertainty about the proper application of the name *maxillosus*. The specimens were taken both by squirting formalin down the burrows and catching the fishes as they popped out and by placing a plastic tube over the entrance and attempting to prod them out with a long wire. One of the jawfishes collected by the formalin method was an adult specimen of *O. whitehursti* carrying in its mouth a ball of eggs so large that the jaws could not be closed (Fig. 1).

When it was transferred to fresh seawater, the fish survived the formalin and was brought in to one of the tanks in Chaplin's laboratory on Hog Island. In spite of the formalin treatment and several handlings with nets, the fish picked up the egg mass in its mouth each time handling caused the mass to be disgorged. Once when the mass lay on the bottom of the tank, it was estimated to be nearly 15 mm in diameter, almost the size of the head of the fish, but the fish took it into its mouth in a single motion. The embryos could easily be seen in the eggs that were visible in the open mouth of the fish. It was at this point, on the evening of 12 May, that the jawfish was photographed.

At some time between 9 P.M. on 12 May and 9 A.M. on 13 May, the eggs hatched, and at the latter time four specimens were preserved in formalin (ANSP 75163). During the following 24 hours, all the remaining baby jawfishes died, and the adult that had incubated them was then preserved (ANSP 75164). The latter individual (56.5 mm in standard length) appears from gross examination to be a male, although its sex must still be verified by histological study of gonadal material. Three of the other five specimens of *O. whitehursti* taken at the same time as the one brooding eggs are ripe females still bearing their eggs.

One of us (C. C. G. C.), on 9 Mar. 1955, witnessed a similar instance of oral brooding in *Opisthognathus maxillosus*. Upon capture, one of four specimens of that species, collected at the same spot as the aforementioned *O. whitehursti*, dis-



Fig. 1. Two views of the adult jawfish, *Opisthognathus whitehursti*, incubating eggs in its mouth.

gorged a mass of yellowish eggs that it had been carrying in its mouth. Unfortunately, only two of the four specimens were preserved, and it is not now known which of the individuals was brooding the eggs. The fact that the eggs were yellowish probably indicates that they were not far along in their development.

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20 December 1956

### Cytochrome *c* Photooxidase of Spinach Chloroplasts

Several different kinds of experimental evidence point to an involvement of cytochromes in the electron-transferring reactions of the photosynthetic process. These include the demonstrated presence of cytochromes in particles that contain the photosynthetic apparatus (1, 2) and measurements of spectrophotometric changes that occur on illumination of photosynthesizing organisms (3). Furthermore, Vernon and Kamen (2, 4) have described a cytochrome *c* photooxidase that is present in extracts of photosynthetic bacteria.

Kamen (2) has discussed the possible functional significance of such an enzyme. In particular, the presence of cytochrome *c* photooxidase can be correlated with the oxidation of cytochromes observed spectrophotometrically on illum-

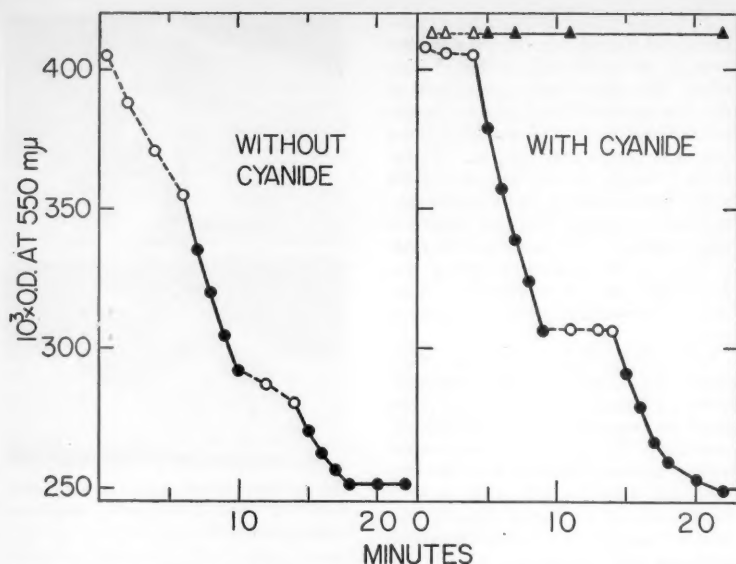


Fig. 1. Photooxidation of cytochrome *c*. Open symbols, dark; solid symbols, light; triangles, heat-inactivated extract. Each reaction mixture contained 40  $\mu$ mole of phosphate buffer of pH 7.0, 0.062  $\mu$ mole of cytochrome *c* of which 0.026  $\mu$ mole was in the reduced ( $\text{Fe}^{2+}$ ) form, and 0.3  $\mu$ mole of KCN where indicated. Water was added to give a final volume of 3.0 ml. The reaction was started by adding 0.20 ml of an extract of spinach chloroplasts in 1-percent digitonin (8). This extract contained 0.18 mg of chlorophyll per milliliter. The intensity of illumination was about 40 ft-ca, and temperature was 20°C.

ination of photosynthetic bacteria *in vivo*.

Although chloroplasts from green leaves have been shown to cause a variety of interesting photooxidations (see, for example, 5), no direct demonstration of the presence of an enzymatic cytochrome photooxidase in leaf chloroplasts has yet, to our knowledge, been described. This report (6) presents evidence for the presence, in digitonin (7) extracts from spinach chloroplasts, of a photooxidase with essentially the same properties as the bacterial cytochrome *c* photooxidase that was described by Vernon and Kamen (4).

In the course of an examination of the ability of spinach chloroplasts to use cytochrome *c* as a Hill reagent, chloroplasts prepared by a modification (8) of a method described by Arnon *et al.* (9) were found to be capable of causing rapid reduction of added cytochrome *c* ( $\text{Fe}^{3+}$ ) on illumination. With these chloroplast preparations, the reduction of added cytochrome ( $\text{Fe}^{3+}$ ) does not proceed to completion but is maintained at a steady state by continued light (10). If at this point 0.1 ml of 1-percent digitonin and 0.3  $\mu$ mole of KCN are added, there is little change in the oxidation-

reduction state of the cytochrome in the dark, but on illumination, the cytochrome *c* ( $\text{Fe}^{2+}$ ) is reoxidized. The digitonin has apparently "unmasked" the photooxidase by inhibiting the photo-reduction. The addition of cyanide is not necessary for the demonstration of the photooxidase, but cyanide brings the photooxidase out more clearly by inhibiting a dark oxidase that is also present.

The cytochrome photooxidase can also be demonstrated directly by use of chloroplast extracts made with 1-percent digitonin (8). The results of the experiments shown in Fig. 1 illustrate the lack of sensitivity of the photooxidase to  $10^{-4}M$  cyanide (which differentiates the photooxidase from the dark oxidase, just as in bacterial preparations). The results given in Fig. 1 also demonstrate the heat sensitivity of the photooxidase, which suggests an enzymatic component and thus differentiates the reaction from the numerous photooxidations catalyzed by chlorophyll solutions (11). The reduced cytochrome *c* used in these experiments was prepared according to the method of Margoliash (12). The photooxidation proceeds until the cytochrome is completely oxidized, and it can be repeated

as often as desired by reducing the oxidized cytochrome with a stoichiometric amount of sodium hydrosulfite. Higher concentrations of reduced cytochrome give higher oxidation rates; that is, the reaction rate is limited by the concentration of cytochrome *c* ( $\text{Fe}^{2+}$ ) in the experiments of Fig. 1. The rate is also dependent on  $\text{O}_2$  and on the amount of chlorophyll preparation added (13).

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1 August 1956

## Book Reviews

**Atomic Energy for Your Business.** Today's key to tomorrow's profit. Arnold Kramish and Eugene M. Zuckert. McKay, New York, 1956. 269 pp. + plates. \$3.95.

The great industrial increase in interest in nuclear applications since the Atomic Energy Act of 1954 became law has resulted in the need for informed guidance available to those business leaders who must make the decisions relative to their company's participation in the field. The present book aims at providing such information. One of the authors, a previous member of the Atomic Energy Commission as well as Assistant Secretary of the Air Force, and now acting as a business consultant in the atomic field, has a rich background for such an objective.

After a brief introduction discussing the typical questions which any non-technical business executive would naturally raise respecting the future of nuclear energy, the authors devote the next three chapters to a very brief historical review and a few very simple physical concepts about the atom and nucleus. A long chapter on applications to industrial processes is followed by a discussion of the political scene in which the nuclear developments have been nurtured. Next, a discussion of atomic developments abroad is followed by specific suggestions and recommendations to be followed by business leaders who desire actively to associate their businesses in this rapidly advancing field of activity.

In various places throughout the book, references are made to the retarding effect upon the program which has resulted from the carrying over of wartime military security into a field where it was too often assumed that the United States held some important "secrets." This has created a wholly new psychology in the United States' mind, and only slowly are we beginning to realize how far into the sands our heads have been buried. Military-weapon design has, of course, always been involved in secrecy, in all countries, but it took the great technologic advance of nuclear fission to becloud our ability to distinguish between fundamental science and engineer-

ing design. The authors clearly bring out this country's indebtedness to various European laboratories for the basic science upon which our wartime engineering development was built.

Certain sections of the political discussions are somewhat colored by the obvious party affiliations of the authors. It is also to be regretted that the contributions of other commissioners who were not directly associated with one of the present authors could not have been evaluated along with those who are included in the discussion.

The book also has a rather long technical appendix, which will probably prove too elementary for a technologist, and by virtue of its being set aside from the general context of the book, the average businessman may unfortunately assume it to be too complex for his perusal. It had better have been included in the proper sections of the text, since it is not of a technical nature which cannot be grasped by any intelligent person. A table of present reactors in the U.S. Power Reactor Program, a dictionary of atomic energy, a section of selected reference material, and a list of the industrial members of the Atomic Industrial Forum constitute the remaining appendices.

The book should be a useful guide to those busy executives who desire to obtain a brief background in the industrial future of nuclear energy.

D. H. LOUGHRIDGE

General Motors Technical Center

**Automatic Digital Calculators.** Andrew D. Booth and Kathleen H. V. Booth. Academic Press, New York; Butterworths, London; ed. 2, 1956. 261 pp. Illus. \$6.

This second edition of *Automatic Digital Calculators* has a very useful bibliography of the computer field, more than twice as long as that in the first edition, published only 2½ years earlier. This tremendous activity in the computer field really requires a larger book than the present one to do it justice.

*Automatic Digital Calculators* is writ-

ten on a slightly more technical level than Bowden's *Faster Than Thought* but does not go into enough of the technical details to be particularly useful to the practicing computer engineer. Its 17 chapters, comprising only 234 pages, tend to give mere glimpses of the complexities of the field. For example, chapter 16, on program design, is mainly taken up with a program for interpolation, giving the reader little feeling for the vast complexity and sophistication in programming now possible. There is little or no mention of Boolean algebra, of information theory, or of the possibilities of digital machines for automation or control purposes.

The book does provide a readable, though faintly archaic, introduction to the field. It gives a little history; a bird's-eye view of the field as a whole; simple discussions of many basic circuits, components, and techniques; and more than a glimpse of the minutiae required to formulate mathematical problems as sets of orders that the machine can follow.

JEROME ROTHSTEIN

Signal Corps Engineering Laboratories

**Diseases of the Skin.** Richard L. Sutton, Jr. Mosby, St. Louis, Mo., ed. 11, 1956. 1479 pp., 1972 illus. \$29.50.

The 11th edition of this standard atlas and encyclopedia of skin disorders surpasses the preceding volumes that have been the lifework of the author and his late father. Brevity, the use of small type for discussions, and an unconventional style of documentation have enabled Richard Sutton, Jr., to present more dermatologic knowledge in less space than was required in the previous edition. By using abbreviated references in the body of the text, he has been able to continue the Suttons' policy of mentioning practically everything of importance in the increasing dermatologic literature.

After receiving my medical education, I completed the courses in the curriculum of the George Washington University School of Law. I found that the citations used in legal writing are much handier than the footnotes used in medical literature. The practicability of shorter references in scientific reports was discussed in this journal in 1954 and 1955 [*Science* 120, 150, 1038; 122, 108]. Sutton, Jr., has demonstrated that a telegraphic type of documentation is practical in medical writing. He has done well at this stage to retain the figure for the year in each reference, inasmuch as physicians are less accustomed than lawyers to library research and do not associate volume numbers with date of publication.

In the preface, the author's analysis



of how he describes a disease will be helpful to those who want to write adequate and readable descriptions of medical entities. The chapter on therapy emphasizes the need for detailed instruction of patients and for a definite order to discontinue all previous medications. The sections on contact dermatitis, the medicolegal aspects of occupational dermatoses, and the treatment of dermatitis venenata are particularly well done. Especially instructive is a hypothetical case presentation that sets forth in detail an interview in which the nature of the dermatitic process is explained to the patient and the latter's cooperation is enlisted in ferreting out the contact irritant.

Insofar as possible, the former dermatological classification based on type of cutaneous manifestation has been replaced by one based on causative agent. The coverage of metabolic skin diseases is six times as extensive as that in the initial printing of the tenth edition in 1939. The doubling of space devoted to embryology of the skin accords with the interest manifested in this subject at the annual meetings of the American Academy of Dermatology and Syphilology in December 1956.

LEON H. WARREN

Parke, Davis & Company

**Beiträge zur Geschichte der Erkenntnis des Erdmagnetismus.** Heinz Balmer. Sauerländer, Aarau, Switzerland, 1956. 892 pp. Illus. DM. 30.

Even before starting his studies at the University of Berne, Switzerland, the author was interested in old scientific illustrations and in biographies of scientists. He selected geography as his major field, the history of Switzerland and physics as his minor fields. A first version of the present book was accepted in 1953 as his Ph.D. thesis.

In the first part of the book (pp. 27-230), the author presents highlights of writings on terrestrial magnetism, starting with selected items from Chinese writings of about 2000 years ago and ending with publications of about 100 years ago. In this section he includes a discussion of the history of technical terms and instruments related to terrestrial magnetism—for example, magnets, the compass and the directions marked on it, and magnetic declination and inclination. The last 16 pages of this section contain historical information related to observations of changes in the direction of the magnetic needle in space and time and to suspected effects of auroras and of oxygen in the atmosphere.

In the second part of the book (pp. 231-520), the author gives extensive selections from writings by Galilei, Mer-

cator, Kepler, William Gilbert, A. von Humboldt, and others. He uses German translations if the originals are in a different language. The third section (pp. 521-579) deals with three special subjects: the myth of the magnetic mountain; ideas which, at the time of Galilei, foreshadowed the magnetic telegraph; and publications on terrestrial magnetism written in Switzerland between about 1500 and 1850. This section includes historic information on sundials. Finally, the author gives a detailed bibliography and biographies of persons mentioned in the text. An author index and a subject index conclude the book.

This book is recommended reading for anyone interested in the history of natural sciences. The 45 illustrations include reproductions of old cuts showing magnetic instruments, especially compasses, and old maps related to problems of terrestrial magnetism—for example, a map by von Humboldt indicating the earth's magnetic field for 1600, 1700, 1800, and 1830, and one by Halley for 1702. Frequently the author includes short discussions of problems which are only distantly related to terrestrial magnetism. Extensive parts of the book are of greater interest to historians than to students of terrestrial magnetism. For example, the author points out that Columbus, on his first voyage, realized, from comparing the direction given by the compass with that obtained from star observations, that they show a difference which changes gradually between Europe and the West Indies; on his second voyage he used this information to determine the approximate position of his ships. On the other hand, of interest to students of terrestrial magnetism are detailed reports on the changes of the earth's magnetic field in course of time, and historic information on attempts to locate the magnetic poles.

The book contains a large amount of historical information, but no modern concepts are discussed. Although probably few will want to read it from cover to cover, everyone interested in the history of science will find interesting sections in it. Typography and reproduction of figures are good.

B. GUTENBERG

California Institute of Technology

**Progress in Cosmic Ray Physics.** vol. III. J. G. Wilson, Ed. North-Holland, Amsterdam; Interscience, New York, 1956. 420 pp. Illus. \$10.50.

The study of cosmic rays has advanced so rapidly in the last decade that it has become impossible even for the specialist to keep up with the many papers published in physics journals in various countries. Also the subject of cosmic

rays has now been subdivided into many specialized aspects, some of them dealing with the nuclear physics problems of high-energy particles, some with the origin of cosmic rays and their distribution near the earth and in the universe. Inevitably this has involved an ever-increasing group of physicists in the cosmic-ray field,—on the one hand, nuclear physicists working on new types of elementary particles with high-energy accelerators, and, on the other hand, astrophysicists and astronomers who are concerned about the phenomena that occur in the atmosphere of stars and in the interstellar space where acceleration of cosmic rays probably takes place.

The need has therefore been great for review articles which summarize the current state of knowledge in a certain field of cosmic-ray investigations. Under the capable editorship of J. G. Wilson of the University of Leeds, several volumes have been published containing contributions by outstanding specialists which summarize the state of research in their field. The present volume, the third in this series, contains four chapters. K. Greisen of Cornell University discusses experiments, their interpretation, and the theory of the so-called "extensive air showers," phenomena which are produced by cosmic rays of extremely high energies, between  $10^{14}$  and  $10^{18}$  electron volts. In complicated nuclear and electromagnetic interactions the original particle produces at lower altitudes in the atmosphere often millions of secondary particles which will hit the earth like a shower over an area of about 100 yards' radius; hence, the name.

The second chapter, written by H. S. Bridge of Massachusetts Institute of Technology, summarizes present knowledge of unstable elementary particles with mass between the electron and the proton (the mesons) and with mass greater than that of the proton (the hyperons). These particles are all produced in high-energy nuclear interactions of cosmic rays, either with atoms in the atmosphere or, in this case, with atoms in photographic plates which are used to detect these events. It is thought that the problem of nuclear forces is closely tied up with the nature of these particles.

The third chapter by R. W. Thompson of Indiana University discusses yet another group of unstable particles observed in cosmic radiation, namely, those carrying no charge. They too play an important part in the theory of nuclear forces.

The last chapter by G. Puppi of the University of Bologna considers the problem of cosmic rays in the atmosphere and investigates what happens to the cosmic-ray energy which enters at the top of the atmosphere. Puppi shows that a certain fraction of the energy goes to



produce the unstable mesons, many of which reach the bottom of the atmosphere and even penetrate deep down into the earth. Another fraction of the energy goes into electrons and photons and eventually appears as ionization in the atmosphere. Another fraction is in the nucleonic component, some of the energy being used to break up atmospheric nuclei. Finally, in many of these interactions, energy escapes in the form of neutrinos and is never recovered. Almost one-fourth of the energy goes into neutrinos, about 60 percent into ionization in the atmosphere, about 10 percent into breaking up nuclei, and the remainder penetrates into the earth.

S. F. SINGER

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#### Recent Progress in Hormone Research.

vol. XII. Proceedings of the Laurentian Hormone Conference, 1955. Gregory Pincus, Ed. Academic Press, New York, 1956. 453 pp. Illus. \$10.

**Vitamins and Hormones.** vol. XIV. Advances in research and applications. Robert S. Harris, G. F. Marrian, and Kenneth V. Thimann. Academic Press, New York, 1956. 486 pp. Illus. \$10.

Both of these books attempt to present the recent advances in endocrinologic and vitamin research. Endocrinology is moving so rapidly that it is essential to have the means whereby new advances can be quickly disseminated. In this aim these two volumes will aid the busy investigator to a large measure but not completely.

*Recent Progress in Hormone Research* is divided into four parts: "Hormone biosynthesis and metabolism," "Hormones and metabolism," "Pituitary hormones," and "Sex hormones." The following chapters add new life to this series: "The adrenal medulla and the biosynthesis of pressor amines" (Paul Hagen and A. D. Welch); "Influence of steroids on cerebral metabolism in man" (Gilbert S. Gordon); "Human urinary gonadotropin" (A. Albert); "Pituitary syndromes in man" (Roberto F. Escamilla); "Male sex hormone and its role in reproduction" (Thaddeus Mann); and "Clinical studies of testicular hormone production" (R. B. Leach, W. O. Maddock, I. Tokuyama, C. A. Paulsen, W. O. Nelson). As a matter of fact, these contributions make this volume a must for the reading list and permanent scientific library of the busy endocrinologic investigator.

The current issue of *Vitamins and Hormones*, volume XIV, presents a truly remarkable synthesis of current and new research developments by eight contributors from Great Britain, Germany, and

the United States. This volume is by far the most scholarly ever produced in this series, and all eight chapters will provide enough stimulation for at least the next 5 years. This volume includes: (i) "Intestinal synthesis of vitamins in the ruminant" (Olaf Mickelsen); (ii) "Some aspects of vitamin-A metabolism" (J. S. Lowe and R. A. Morton); (iii) "Regulation of carbohydrate metabolism in isolated tissues" (A. E. Renold, J. Ashmore, A. Baird Hastings); (iv) "Experimental hyperglycemic states not primarily due to a lack of insulin" (K. H. Shull and Jean Mayer); (v) "Biochemical studies on insect hormones" (Peter Karlsson); (vi) "Glucuronide metabolism, with special reference to the steroid hormones" (G. A. Levvy); (vii) "Bioassay of pituitary and placental gonadotropins in relation to clinical problems in man" (J. A. Loraine); and (viii) "Microbiological transformations of steroids and their applications to the synthesis of hormones" (S. H. Eppstein, P. D. Meister, H. C. Murray, D. H. Peterson).

It is encouraging to have our foreign colleagues contribute so unselfishly to these two volumes. The endocrinology of the male receives a comprehensive evaluation and elucidation in the scholarly approach of Mann. His personal researches in a world-famous laboratory and his critical appraisal of hitherto embalmed "facts" provide not only a clear statement of male endocrinology but a sterling example of the scientific method. The pioneering researches of Mann and his associates at Cambridge University have illuminated an area of endocrinology that has been befogged with numerous misconceptions. Following the comments on the role of the male sex hormone in reproduction by Mann, in *Recent Progress in Hormone Research*, the observations on the clinical studies of testicular hormone production, in the chapter by R. B. Leach and his colleagues, prove of great scientific interest. This chapter indicates that (i) the Leydig cells, rather than Sertoli or germinal cells, are the source of estrogen secreted by the human testis; (ii) adult functioning Leydig cells respond to stimulation with human chorionic gonadotropin by secreting increased amounts of both androgens and estrogens; (iii) the increased titers of androgen and estrogen act on the pituitary, thereby inhibiting the secretion of the gametogenic hormone (F. S. H. in the male) and thus producing seminiferous tubule damage; and (iv) estrogen secretion is a more reliable and sensitive indication of Leydig cell function than is the excretion of the numerous 17-ketosteroids. (The authors conclude that "the most probable explanation for this is that 80 percent or more of estrogens normally arise from the testes, whereas less than half of the

17-ketosteroids originate from Leydig cell secretion, the majority being of adrenal cortical origin.") These two chapters on the male sex hormone are enlightening both from a research point of view and as an important contribution to the medical profession.

Levy's chapter on glucuronide metabolism, with special reference to the steroid hormones, in *Vitamins and Hormones*, represents a careful appraisal of what is known concerning glucuronide metabolism. This chapter, which is heavily laden with significant references, indicates that (i) "quantitative changes in the  $\beta$ -glucuronidase activity of animal tissues do not necessarily provide qualitative evidence on the function of the enzyme"; (ii) "so far as the possible function of  $\beta$ -glucuronidase is concerned, there is nothing on which to base an opinion except its hydrolytic action on steroid and other glucuronides"; (iii) "the  $\beta$ -glucuronidase activity of all body tissues appears to be under endocrine control. It does not follow that an alteration in enzyme activity produced by a hormone is an essential feature of the metabolism of that hormone, nor that it is in any sense an adaptive response"; (iv) "in healthy individuals, deviations from the mean in the  $\beta$ -glucuronidase activity of an organ or body fluid may reflect variations in endocrine constitution, and in the extreme case peculiar susceptibility to degenerative disease"; and finally, (v) "the activity of the enzyme in sex and nonsex organs is under endocrine control and is also governed by hereditary factors." Biochemists working in this active area of research will find Levy's analysis of present-day knowledge on the  $\beta$ -glucuronidase enzyme extremely worth while.

In the final analysis, both volumes are factual and are truly an asset to the scientific literature. The editors of both volumes are to be congratulated for their continued service in these ever-expanding areas of knowledge concerned with the hormones and vitamins.

JOSEPH T. VELARDO

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**Principles of Color Television.** Hazeltine Laboratories Staff. Knox McIlwain and Charles E. Dean, Eds. Wiley, New York; Chapman & Hall, London, 1956. 595 pp. Illus. \$13.

When, on 17 December 1953, the Federal Communications Commission gave its approval to the transmission standards for compatible color television broadcasting which had been proposed by the National Television System Committee, new and unfamiliar problems were posed for the rank and file of engi-

neers in the field. Multiplexing of the three signals required for transmitting color into the same frequency band used for monochrome transmission was based on the application of two principles which were old in the communication art, but of which only a few specialists were aware. The techniques of circuit design required to insure the interference-free transmission of this composite signal and the recovery of its components in a receiver also were well known only to those engineers who were regularly engaged in the design of complicated communication systems. In addition, there was hardly an electronic engineer who had heard of, much less who was familiar with, the sciences of photometry and of colorimetry.

The Hazeltine Corporation set out to correct this situation for its licensees. First, by issuing a series of reports, and then by operating a school in which these reports were used as a textbook, the engineers in the organizations of the Hazeltine licensees were given an opportunity to become familiar with those principles which overnight had become important in television engineering. Tempered by the criticisms of other experts, and by their use as a textbook, these reports, along with some more recent material, became the basis for *Principles of Color Television*.

The ground covered by this book is indicated by its chapter headings: "Light and photometry," "Color perception," "Color space and color triangles," "Colorimetry," "Color in a television system," "Required information content," "Characteristics of the eye," "The choice of the color components and their interleaving in the composite signal," "Production of the composite color signal," "Synchronization," "Nonlinear amplitude relations and gamma correction," "The color television standards of the FCC," "Equipment for producing the transmitted signal," "Color television receivers," "Decoders for three-gun displays," "Decoders for one-gun picture tubes," "Test and measuring methods," and "Glossary of color television terms." This list is indeed a promise that every fact has been presented that a television engineer requires in order to become skilled in color. This promise is fulfilled.

Twelve members of the Hazeltine organization contributed to the text of *Principles of Color Television*. Skillful editing by Knox McIlwain and Charles E. Dean has done much in reducing the differences of style and treatment of the several authors. Such differences as remain are no greater than one might expect from the disparity of subjects, as is indicated by the chapter headings.

This is an authoritative textbook and reference book. The Hazeltine Corporation, which sponsored it, has made many

important contributions to the standards under which present-day color television broadcasting is carried out. And of the 12 contributing authors, eight were parties to the deliberations of the National Television System Committee in which the pros and cons of every detail of these standards were argued at length.

*Principles of Color Television* is recommended reading for anyone with some knowledge of monochrome television techniques who wishes to learn the fundamentals of our present system of color television broadcasting. The generous list of references at the end of each chapter of this book will be helpful to one in search of more information than is contained between its covers.

W. T. WINTRINGHAM

Bell Telephone Laboratories

## New Books

*Patent Notes for Engineers.* C. D. Tuska. McGraw-Hill, New York, ed. 7, 1957. 192 pp. \$4.

*The Validation of Scientific Theories.* Philipp G. Frank, Ed. Beacon, Boston, 1957. 242 pp. \$4.

*Biochemical Individuality.* The basis for the genotrophic concept. Roger J. Williams. Wiley, New York; Chapman & Hall, London, 1956. 214 pp. \$5.75.

*Man's Physical Universe.* A survey of physical sciences for colleges. Arthur T. Bawden. Macmillan, New York, ed. 4, 1957. 822 pp. \$6.25.

*Amino Acid Handbook.* Methods and results of protein analysis. Richard J. Block and Kathryn W. Weiss. Thomas, Springfield, Ill., 1956. 386 pp. \$10.50.

*Relaxation Methods in Theoretical Physics.* vol. II. A continuation of the treatise *Relaxation Methods in Engineering Science*. R. V. Southwell. Clarendon, Oxford, 1956. 522 pp. \$8.80.

*Principles of Zoology.* John A. Moore. Oxford University Press, New York, 1957. 667 pp. \$7.50.

*Mechanics for Engineers.* Statics and dynamics. Ferdinand P. Beer and E. Russell Johnston, Jr. McGraw-Hill, New York, 1957. 673 pp. \$8.

*No Room for Wild Animals.* Bernhard Grzimek. (Translated by R. H. Stevens.) Norton, New York, 1957. 271 pp. \$3.95.

*Fundamentals of Horticulture.* A textbook designed for courses in general horticulture. J. B. Edmond, A. M. Musser, F. S. Andrews. McGraw-Hill, New York, ed. 2, 1957. 456 pp. \$6.75.

*Dahlak, with the Italian National Under-Water Expedition in the Red Sea.* Gianni Roghi and Francesco Baschieri. Translated by Priscilla Hastings. Eleanor Brockett, Ed. Essential Books, Fair Lawn, N.J., 1957. 280 pp. \$6.

*British Scientific and Technical Books.* A select list of recommended books published in Great Britain and the Commonwealth in the years 1935-1952. Published for Aslib. Clarke, London; Hafner, New York, 1956. 364 pp. \$11.25.

*Discussions on Child Development.* A consideration of the biological, psychological, and cultural approaches to the understanding of human development and behavior. vol. I, *The Proceedings of the First Meeting of the World Health Organization Study Group on the Psychobiological Development of the Child*, Geneva, 1953; vol. II, *The Proceedings of the Second Meeting of the World Health Organization Study Group on the Psychobiological Development of the Child*, London, 1954. J. M. Tanner and Barbel Inhelder, Eds. International Universities Press, New York, 1957. 240 pp.; 271 pp. \$10 per set.

*Transactions of the Symposium on Partial Differential Equations Held at the University of California, at Berkeley, 20 June-1 July 1955.* Sponsored by Office of Naval Research; University of California, Berkeley; University of Kansas, Lawrence; and the American Mathematical Society. Interscience, New York, 1956. 334 pp. \$6.50.

*The Encyclopedia of Chemistry.* George L. Clark, Ed. Reinhold, New York; Chapman & Hall, London, 1957. 1037 pp.

*Vertebrate Embryology.* Robert S. McEwen. Holt, New York, ed. 4, 1957. 701 pp. \$6.50.

*Faune de France.* 60. Bryozoaires. pt. I, Entoproctes, Phylactolèmes, Cténostomes. Marcel Prenant and Geneviève Bobin. Lechevalier, Paris, 1956. 398 pp. Paper, F. 5000.

*The Leibniz-Clarke Correspondence.* Together with extracts from Newton's *Principia and Opticks*, edited with introduction and notes by H. G. Alexander. Philosophical Library, New York, 1956. 200 pp. \$4.75.

*A History of the Ancient Southwest.* Harold S. Gladwin. Wheelwright, Portland, Maine, 1957. 383 pp. \$8.50.

*Biographical Memoirs of Fellows of the Royal Society.* vol. 2. Royal Society, London, 1956. 345 pp. 30s.

*Statistics for Management.* A simplified introduction to statistics. B. J. Mandel. Dangary, Baltimore, 1956. 408 pp.

*Annual Review of Nuclear Science.* vol. 6. James G. Beckerley, Martin D. Kamen, Leonard I. Schiff. Annual Reviews, Palo Alto, Calif., 1956. 471 pp. \$7.

*Gas Dynamics.* Klaus Oswatitsch. English version by Gustav Kuerti. Academic Press, New York, 1956. 610 pp. \$12.

*Handbook for Vegetable Growers.* James E. Knott. Wiley, New York; Chapman & Hall, London, 1957. 238 pp. \$3.95.

*Enzyme, Antigen and Virus.* A study of macromolecular pattern in action. F. Macfarlane Burnet. Cambridge University Press, London, 1956. 193 pp. \$3.50.

*Medical Department, United States Army. Surgery in World War II. Orthopedic Surgery in the European Theater of Operations.* 397 pp. \$4. 1956. *General Surgery II.* 417 pp. \$4.25. 1955. John B. Coates, Jr., Ed. Office of the Surgeon General, Department of the Army, Washington (order from Supt. of Documents, GPO, Washington 25).

*Classics in Arterial Hypertension.* Arthur Ruskin. Thomas, Springfield, Ill., 1956. 358 pp. \$9.50.

## Meetings and Societies

### Calorimetry

The 11th annual Calorimetry Conference was held at Johns Hopkins University, Baltimore, Md., on 14-15 Sept. 1956. Attendance at the conference reached a new peak; between 140 and 150 physicists, chemists, and engineers, representing academic, government, and industrial laboratories in the United States, Canada, Europe, and Australia, were present.

The third annual Hugh M. Huffman memorial lecture was given by Frederick D. Rossini (Carnegie Institute of Technology, Pittsburgh, Pa.). His address, "Chemical thermodynamics in the International Union of Pure and Applied Chemistry," gave in detail the origin and administrative organization of the union, together with its places of meeting, its personnel, and its functions.

Elliott W. Montroll (University of Maryland) presented an address on the "Theory of the frequency spectrum of solids." Montroll reviewed briefly the general theory of lattice vibrations and the spectrum obtained for a simple cubic lattice, assuming first, nearest neighbor interaction only, and then next-nearest neighbor interaction. He next considered the two-dimensional crystal and showed that such a structure is stable only at low temperatures. He concluded his address with a description of the effects of vacancies and isotopes in the lattice structure.

The concluding event of the 2-day session was an impressive address on guided missiles, illustrated with slides and motion-pictures, given by R. E. Gibson (Johns Hopkins Applied Physics Laboratories).

A summary of the 24 contributed papers presented at the conference is briefly as follows: The first three papers of the opening session were concerned with the properties of various low-temperature thermometers. The first, by J. G. Aston (Pennsylvania State University) described the use of the copper-constantan thermocouple as a means of establishing a laboratory temperature scale accurate to 0.1°K. Aston offered constantan wire to those interested in establishing such a scale, together with an electromotive force table which he

has constructed for the temperature interval between the oxygen and hydrogen points.

Very small single crystals (about 0.02 by 0.02 by 0.20 inch) of germanium containing a small amount of arsenic have been used as resistance thermometer elements for low-temperature measurements by J. E. Kunzler, T. H. Geballe, and G. W. Hull (Bell Telephone Laboratories). The crystals were mounted in a Teflon-lined cylindrical platinum capsule, about 0.125 inch in diameter and 0.5 inch long. The authors report that this resistance thermometer is unusually stable and that, after repeated cyclings between room temperature and the liquid helium region, the helium normal boiling-point (4.2°K) resistance is reproduced within 10<sup>-4</sup> degree. The resistance stability in the presence of a magnetic field is yet to be determined.

Carbon composition resistors used as resistance thermometers show appreciably less stability than "doped" germanium. However, J. R. Clement, R. L. Dolecek, and J. K. Logan (Naval Research Laboratory) have found that all the various resistance-temperature plots obtained for a given Allen-Bradley resistor may be superposed by proper re-scaling of the resistance and temperature axes. If curves of *different* resistors (1/10-, 1/2-, and 1-watt sizes) are compared, a universal function relating "scaled" resistance and "scaled" temperature can be defined with an accuracy which increases as the temperature is lowered below room temperature.

Following the papers on thermometry, W. DeSorbo (General Electric Research Laboratories) discussed the application of microcalorimetry to the kinetics of precipitation and solid-solid transformations. The effect of imperfections, particle size, and cold work on the  $\alpha$ - $\beta$  transformation in the Pb-Sn and Al-Cu alloys was presented.

The electronic heat capacity of Cu, of Cu-3-percent Zn, and Cu-1-percent Cd, was measured by J. A. Rayne and W. R. G. Kemp (Commonwealth Scientific and Industrial Organization, Sydney, Australia). Comparison of the  $\gamma$  values for the zinc and cadmium alloys suggest that the difference is not due to a valence electron effect but to the large dis-

tortion occurring around the cadmium atoms. It was suggested that similar effects could be responsible for the discrepancies of the  $\gamma$  values for many transition elements.

The specific heat of KBr and KI crystals about 5 mm on edge was measured over the range 2.5° to 270°K by W. T. Berg and J. A. Morrison (National Research Laboratories, Ottawa, Canada). The behavior of the Debye  $\theta$  with temperature, starting at the lowest temperatures, shows for KBr and KI an initial decline followed by a rise to a maximum in the region 70° to 120°K, and then a rapid decline. Less complete data on NaI and KCl also show the low-temperature dip. The values of the Debye  $\theta$  are in agreement with compressibility data.

The enthalpy of formation of solid alloys is being investigated calorimetrically by R. A. Oriani (General Electric Research Laboratory). Two calorimeters are used, one being a "dummy" to determine corrections and the other to determine the heat of solution of various alloys. The method consists in measuring the heat of solution of an alloy (Ag-Au and Cu-Ni systems studied) in molten tin and then that of the pure constituents. The difference is the heat of formation of the alloy. Measurements can be carried out up to 1000°C.

A new adiabatic calorimeter for measurement in the range 40° to 500°C was described by E. D. West (National Bureau of Standards). Objectives in the design were 0.1-percent reproducibility, easy change of sample without disrupting measuring circuits, and sufficient automatic control (shield temperatures) so that one person can make measurements. The objectives were apparently very well realized in the standardizing tests and in the measurements thus far carried out.

The details of a calorimeter for measurements on the alkali metals in the 2° to 20°K range was presented by F. D. Manchester (National Research Council, Ottawa). This was followed by the description of a "semiadiabatic" calorimeter (environment kept at temperature near to that of the calorimeter) by J. E. Kunzler (Bell Telephone Laboratories).

D. H. Andrews (Johns Hopkins University) then opened a session devoted to automatic calorimetry by describing the equipment, methods, and results of the Hopkins automatic calorimeter. This unit was designed to measure the heat capacity of pure liquids, as well as binary and ternary mixtures, over the range 0° to 50°C. The method of continuous heating is used, featured by a programed servo control. The relative accuracy of measurements on diphenylmethane and diphenylether was found to be 0.02 to 0.03 percent.



A completely automatic adiabatic calorimeter covering the range from helium temperatures to 330°K, and under development for about 10 years, was described by D. R. Stull (Dow Chemical Co.). The calorimeter fits in the experimental cavity of a Collins helium cryostat, needs slight manual attention up to about 40°K, and is completely automatic in operation and recording from 40°K to room temperature. Time for a full run may be as long as 80 hours.

A panel consisting of D. H. Andrews (chairman), D. R. Stull, E. D. West, and G. T. Furukawa concluded the automatic calorimetry session by a panel discussion, which included participation from the floor.

The second day's session was opened by a paper on direct calorimetric measurements of the heat of vaporization of liquid He<sup>3</sup> by D. W. Osborne, B. M. Abraham, and B. Weinstock (Argonne National Laboratory). Data taken over the range 1.2° to 2.1°K were used to calculate more accurate values of the entropy of the liquid. The measured heats of vaporization were considered accurate to 0.2 percent. The entropy value of the liquid at 1.5°K was found to be  $2.60 \pm 0.03$  calories per mole, per degree. The virial data of Keller and the vapor pressure-temperature relation for He<sup>3</sup> were indirectly confirmed.

Using an improved experimental arrangement, H. C. Kramers (Leiden University) remeasured the specific heat of liquid He<sup>4</sup> below the  $\lambda$  point. Above 0.7°K the data are unchanged from the earlier values. Below 0.6°K both the older values and the present data follow the  $T^3$  law, but the numerical data are now in excellent agreement with Landau's theory, using a velocity of sound at 0°K of 240 meters per second. The current measurements give  $C_v = 0.0204 T^3$  joules per gram, per degree.

R. P. Hudson, (National Bureau of Standards) surveyed his recent measurements on absolute temperature determinations below 1°K using chromium methyl-ammonium alum. Previous measurements on this salt were made by Gardner and Kurti. The results show that the reproducibility from specimen to specimen varies, and  $S/R$  measurements give different values at different times. Thus entropy-temperature values must be determined individually for each salt specimen.

E. Ambler (National Bureau of Standards) discussed the possibilities of using dielectric, ferroelectric, and magnetic hysteresis losses as a means of supplying heat uniformly throughout the body of paramagnetic salts at temperatures below 1°K. He concluded that none of these methods appear useful.

L. D. Roberts, J. W. T. Dabbs, and

G. W. Parker (Oak Ridge National Laboratory) reported an investigation of the Schottky anomaly in the specific heat of  $U^{235}O_2F_2$ , arising from the coupling of the nuclear electric quadrupole moment to the electric field of the U-O bonding orbitals. The work was done to assist in the interpretation of the anisotropy of  $\alpha$  particles and fission fragments from nuclei aligned by virtue of this type of coupling.

Measurements made in the Clarendon Laboratory, Oxford, of the specific heat of 14 transitional metals and 10 non-transition elements over the temperature range 1° to 20°K were described by N. M. Wolcott, Naval Research Laboratory). The variation of the Debye  $\theta$  with temperature was given, together with a discussion of the electronic specific heats.

A graphical method for evaluating the heat capacity of a specimen from its temperature response in the after-heating period was presented by J. S. Kouvel (General Electric Research Laboratory). The applicability of the method where there are appreciable time-lags owing to thermal gradients in the specimen or to characteristics of a galvanometer was indicated. Data on the specific heat of a magnetite crystal at liquid helium temperatures, obtained by this method, concluded the paper.

A study of the factors affecting the heat capacity of molecular lattices below 50°K was considered by Ruth Aranow (Johns Hopkins University). In this instance calculations were made on paraffin, and these were checked against experimental measurements made at Johns Hopkins. Contributions to the internal energy were considered from (i) intramolecular vibrations, (ii) torsional motions, and (iii) lattice vibrations. An empirical fit with the experimental data required that the vibrations be coupled in the crystal.

Observation of unusual effects of impurities on the thermal properties of *l*-decene and *cis*-decahydronaphthalene were described in a paper by J. P. McCullough, J. F. Messerly, and Guy Waddington (U.S. Bureau of Mines). These consisted of two different heat-capacity curves and two different melting-point curves for the former substance, while the number for the latter substance was three. These effects were considered to be due to the different distribution of impurities in the sample.

Three techniques used in combustion calorimetry involving volatile solid samples were presented by W. N. Hubbard, D. W. Scott, W. D. Good, and Guy Waddington (U.S. Bureau of Mines). These may be described briefly as the glass-ampoule method, the covered-glass-dish method, and finally the plastic (Mylar)-bag method.

J. L. Margrave (University of Wisconsin)

measured the heat of reaction of four fluorine compounds by means of bomb calorimetry and from the measurements determined the heat of formation of  $CF_4$ ,  $C_2F_4$ ,  $CH_2F_2$ ,  $ClO_2F$ , and several other carbon-fluorine-chlorine compounds.

A résumé of work on the temperature scale being carried on at the National Bureau of Standards was given by C. W. Beckett, E. R. Prosen (National Bureau of Standards) reported on the use and availability of standard calorimetric samples.

The closing paper of the conference consisted of a correlation of spectral and thermodynamic data on cyclohexane, by T. J. Mathia and J. B. DiGiorgio (Johns Hopkins University).

Edgar F. Westrum, Jr. (University of Michigan), the retiring conference chairman, presided at the business meeting. The incoming conference chairman is Henry A. Boorse (Barnard College, Columbia University). Donald H. Andrews (Johns Hopkins University) was voted chairman-elect, and Darrell W. Osborne (Argonne National Laboratory) was elected a director to serve for 2 years.

In conclusion, it was agreed that the incoming chairman should investigate the possibility of having the "doped" germanium thermometers described by Kunzler made available for further tests in the various low-temperature laboratories.

HENRY A. BOORSE

Barnard College, Columbia University, New York, N. Y.

## Nuclear Reactions

The International Conference on Nuclear Reactions met in Amsterdam, 2-7 July, under the sponsorship of UNESCO, the International Union of Pure and Applied Physics, and the Netherlands Physical Society. Conference participants numbered approximately 500, with the following countries represented in strength: the Netherlands, 150; the United Kingdom, France, and the U.S.A., 70 each; the U.S.S.R., 27; Norway, Sweden, Denmark, Italy, and Germany, 20 each; Yugoslavia and Belgium, 10 each. One or more physicists were also present from Czechoslovakia, Poland, Hungary, East Germany, Spain, Israel, Finland, Japan, India, Argentina, and Mexico.

The session topics and invited speakers were as follows: General introduction (H. A. Bethe); Particle reactions at low energies (R. F. Christy, P. C. Gugelot, T. Huus, D. J. Hughes); Theoretical models of low-energy processes (V. F. Weisskopf, A. Bohr, H. A. Bethe); Capture and photoreactions (P. M. Endt,



D. H. Wilkinson); Stripping and pickup reactions (J. R. Hoyt, J. Horowitz); High-energy scattering (E. Segrè, L. Van Hove); Fission, spallation, heavy-ion acceleration (J. H. Fremlin, J. A. Wheeler); Concluding remarks (L. Rosenfeld).

The conference discussion centered on the following problems: the description of nuclear scattering by the optical model; the reconciliation of the independent-particle and collective descriptions of nuclear structure, and the theoretical justification of the independent-particle model (IPM); the competition between mechanisms of direct interaction and compound nucleus formation in nuclear transformations.

The review of work on the optical model (Van Hove) and various contributed papers testified to the remarkable success of this simple model in the description of nuclear scattering over a broad range of energies and atomic weights. The bulk properties of the nucleus—for example, the refractive index and opacity of nuclear matter—are now rather well determined by the comparison of optical calculations with scattering data up to 1 Bev. It is most satisfying, moreover, to report that these bulk characteristics can be derived from the properties of the elementary nucleon-nucleon interaction (Brueckner, Bethe, Skyrme).

Several papers hinted at a union of the apparently incompatible independent-particle and collective models of the nucleus, based, respectively, on the assumptions of weak and strong forces between nucleons. The level scheme of aluminum, for example—a nucleus usually regarded as outside the domain of the collective description but suitable for application of the independent-particle model—was reported (Gove, Litherland, Paul, Almqvist, Bartholomew, Bromley) to be given with comparable accuracy by both models. The nuclear photoeffect, on the other hand, most often considered from a collective viewpoint, may also be interpretable by independent-particle transitions (Wilkinson).

Some advances were reported in attempts to provide a theoretical foundation for the successes of the independent-particle model. Bethe described investigations (Brueckner, Bethe) of the nuclear many-body problem which seem to bear out earlier suggestions that, although nuclear forces are known from nucleon-nucleon scattering experiments to be quite strong and the independent-particle model is based on the assumption of weak forces, the validity of this model can still be understood as a consequence of the Pauli principle, which weakens the effective nucleon-nucleon interaction by suppressing collisions in the nuclear interior, acting here just as

it does in metals, in which the mean free paths of conduction electrons are enormously increased beyond classical estimates by the suppression of electron-ion collisions.

Little progress was indicated in the longstanding effort to understand the competition between direct interaction and compound nucleus formation. The mechanism of direct interaction appears to play an important role in reactions at surprisingly low energies, where compound nucleus formation had been thought to occur exclusively, but the circumstances in which one mechanism or the other will dominate are still obscure. Experimental studies of helium-3 reactions may be especially useful in this connection (Holmgren, Johnston, Geer, Wolicki, Almqvist, Bromley, Ferguson, Gove, Litherland, Paul).

Delegates from the Western nations were especially interested in the Soviet contributions to low-energy physics. The activity of the Soviet theorists in this field is apparently extensive, but one gains the impression that their experimental effort is substantially smaller than that of the United States and Western Europe, in contrast to the extraordinary activity of U.S.S.R. scientists in the high-energy field.

ROBERT JASTROW  
*Naval Research Laboratory,  
Washington, D.C.*

### Pan American Cytology Congress

Physicians planning to attend the First Pan American Cancer Cytology Congress should confirm their reservations at an early date. The congress, first of its kind ever held, is scheduled for the Eden Roc Hotel, Miami Beach, 25-29 Apr. Supported by a grant from the Department of Health, Education and Welfare of the U.S. Public Health Service, the congress is attracting medical practitioners and cancer research scientists from the western hemisphere. The U.S. Department of State has mailed invitations to the health ministries of 21 nations of the Pan American area on behalf of the organizing committee of the congress.

The program will provide the latest advances in the application of cytology in early cancer diagnosis and in research. There will be clinical papers and extensive participation by basic research scientists who work on such related phases of cancer as radioisotopes, genetics, electron microscopy, immunology, and leukemias. The theme of the meeting will be "Cancer protection through early detection."

The Pan American Cancer Cytology Congress is sponsored by the Southern Society of Cancer Cytology, the Cancer

Cytology Foundation of America, Inc., N.Y., the University of Miami, and the Cancer Institute at Miami. Inquiries should be sent to the secretary of the congress, Dr. George Gey, Johns Hopkins University, Baltimore, Md.

### Bioclimatology and Biometeorology

The International Society of Bioclimatology and Biometeorology will hold its first scientific congress in Vienna, Austria, 23-27 Sept. 1957. There will be sessions on general, phytological, zoological, human, and cosmic bioclimatology. Those interested in submitting papers or in attending the congress should write to Dr. S. W. Tromp, Hofbrouckerlaan 54, Oegstgeest (Leiden), Holland.

### Italian Physical Society

The Italian Physical Society is organizing the Third International Conference on Ionization Phenomena in Gases, thus continuing the series of conferences initiated by A. von Engel at Oxford in 1953 and followed up by A. B. Dorgelo at Delft in 1955. The third conference will be held in the building of the "Fondazione G. Cini" in Venice from 11 to 15 June 1957.

The subjects to be discussed are divided into the following four general sections: (i) "Fundamental processes in ionized gases," (ii) "Mechanism and properties of various types of discharges," (iii) "Nuclear reactions in discharges; contraction mechanisms, neutron production, etc.," and (iv) "Technical and instrumental questions; applications."

Every section will include general surveys and short communications on the various topics. English will be the preferred language. The proceedings of the conference will be published in the supplement of *Il Nuovo Cimento*. Those who wish to attend the conference should write *before 15 Mar.* to the general secretary, Prof. Ugo Facchini, Laboratori CISE, Via Procaccini 1, Milano, Italy.

### Humanist and Ethical Union

The second Congress of the International Humanist and Ethical Union will be held in Conway Hall, London, England 26-31 July. Lord Boyd Orr, president of the congress, Julian Huxley, H. J. Muller, and J. Bronowski, among others, will speak on the general theme "Mankind now." Meetings and discussions are open to those interested. For further information write to: Stanton Coit House, 13 Prince of Wales Terrace, London W S, England. Applications must be received *by 31 May*.

## Interamerican Congress of Psychology

The Fourth Interamerican Congress of Psychology, sponsored by the Interamerican Society of Psychology, was held at the University of Puerto Rico, 26-30 Dec. 1956. The central theme of the congress, "The psychology and psychopathology of group behavior," was discussed in a series of nine symposia (based on the presentation of 64 research reports and surveys).

Sponsorship, in addition to that afforded by the Interamerican Society, was also given to the Congress by the University of Puerto Rico and by the Puerto Rican Psychological Association. The delegates included representatives from Canada, Puerto Rico, the United States, Mexico, Brazil, Venezuela, and Colombia.

The officers elected for 1957 at the business meeting of the congress are as follows: Otto Klineberg, Columbia University, U.S.A.; pres.-elect, Guillermo Davila, National University, Mexico; v. pres., Gustave M. Gilbert, Michigan State University, U.S.A.; sec.-gen., Werner Wolff, Bard College, U.S.A.; exec. sec., Samuel Pearlman, Brooklyn College, U.S.A.; treas., Robert B. Malmo, McGill University, Canada. The 1957 meeting of the society will be held, according to present plans, at the National University of Mexico, Mexico City, in December.

## Wildflower Pilgrimage

The Seventh Annual Wildflower Pilgrimage will be held in the Great Smoky Mountains National Park at Gatlinburg, Tenn., 24-27 Apr. Field trips and motorcades will be led daily by park naturalists, trained botanists, and photographers. In addition to wildflowers, one trip will feature mosses and ferns. There will be morning bird trips and illustrated lectures in the evening. For further details write to the Department of Botany, the University of Tennessee, Knoxville.

## IRE Affiliate Plan

The Board of Directors of the Institute of Radio Engineers, at its January meeting, adopted a plan which will permit qualified non-IRE members to become affiliated with certain of the IRE professional groups without first having to join the IRE itself. Adoption of the affiliate plan is regarded as one of the most important changes that has been made to the IRE structure in its 45-year history.

In effect, the IRE is extending the

specialized services of its 24 professional groups to every field of engineering and science, in order to provide more effectively for the rapidly spreading influence of electronics in every branch of scientific and technological life. The affiliate plan is expected to be especially beneficial in the field of medical electronics, for it will permit medical doctors and biologists who ordinarily would not be interested in joining the IRE to participate in the activities of the IRE Professional Group on Medical Electronics.

## Pan American Ophthalmology Plans New York Meeting

The Pan American Association of Ophthalmology and the National Society for the Prevention of Blindness will meet in New York 7-10 Apr. The joint meeting will have headquarters at the Hotel Statler.

Addresses of welcome will be given by Frank B. Berry, Assistant Secretary of Defense for Medical Affairs, Washington, D.C., representing the United States Government, and by Major General Dan C. Ogle, Surgeon General of the U.S. Air Force. Also, Mason H. Bigelow, president of the National Society for the Prevention of Blindness, and Brittain F. Payne, president of the Pan American Association of Ophthalmology, will greet the delegates on behalf of their respective organizations.

William L. Benedict, Rochester, Minn., executive secretary-treasurer of the American Academy of Ophthalmology and Otolaryngology, is scheduled to speak for the ophthalmologists of the United States, and Moacyr E. Alvaro, São Paulo, Brazil, executive director of the Pan American Association, for those of Latin American countries.

The scientific program will include three symposia on official themes, addresses by representatives of ophthalmological societies of South and Central America, Mexico, and Cuba; free papers; motion pictures; scientific exhibits; and surgical clinics. The three special symposia and the moderators are as follows: "Diseases of the ocular fundus," George N. Wise, New York; "Ophthalmic surgery," John H. Dunnington, New York; and "Therapeutics in present-day ophthalmology," Irving H. Leopold, Philadelphia.

John M. McLean, New York, is arranging the program of papers; Wendell L. Hughes, Hempstead, N.Y., the motion pictures; J. Gordon Cole, the surgical clinics; and Gerald Fonda, Short Hills, N.J., the scientific exhibits. All ophthalmologists are invited to the congress. Hotel reservations should be made direct with the Hotel Statler, New York.

## Ninth Pacific Science Congress

The Science Society of Thailand has invited the National Research Council and, through it, scientists and representatives of institutions in the United States, to participate in the Ninth Pacific Science Congress. This congress will be held in Bangkok from 18 Nov. to 9 Dec. 1957, under the auspices of the Government of Thailand and the Science Society of Thailand. The National Research Council is the representative of the United States in the Pacific Science Association, which has been responsible for the eight previous Pacific Science Congresses, the first of which was held in 1920.

Several members of the NRC Pacific Science Board who have visited Bangkok have been informed that the Organizing Committee for the congress would welcome a large delegation of U.S. scientists to take part in the planned symposia, as well as the general scientific program of the congress. The Pacific Science Board is anxious that the full measure of this country's scientific cooperation be extended to help assure the success of the Thai organizing committee's plans. Secretary general of the congress is Charn Ratanarat, Department of Science, Ministry of Industry, Bangkok.

The Eighth Pacific Science Congress was held in the Philippines in 1953, with 123 U.S. participants. During the 4 years that will have elapsed between the Manila congress and the one to be held in Bangkok, active scientific work in many disciplines has been under way in various parts of the Pacific. Much of this work is related to the subjects discussed and the recommendations adopted by the eighth congress. The cooperative activities of the International Geophysical Year will also be well under way.

Authors will be given 10 minutes to present their papers, with an extension of not more than 10 minutes for discussion. Abstracts for contributed papers should not exceed 400 words. Papers as well as abstracts in final form must be delivered to the Organizing Committee *not later than 1 Aug.*

Manuscripts must be typewritten double-spaced, and an English translation must be submitted, for all papers will be duplicated in English. Members of the congress who will not be able to attend in person may send only one paper; this must be read to the congress by a member designated by the author.

For further information and a copy of the preliminary program, which lists the 18 organizing chairmen, write to the executive director of the Pacific Science Board, Dr. Harold J. Coolidge, National Academy of Sciences-National Research Council, Washington 25, D.C.

## Radiation Research

The annual meeting of the Radiation Research Society will be held at Rochester, N.Y., 13-15 May. In addition to submitted papers, there will be two symposia: one concerned with radiation genetics and the other with radiation chemistry. There will also be a series of invited lectures, the topics and speakers to be announced later. Those desiring to report original research on radiation effects, or desiring attendance information, should communicate with the secretary of the society, Dr. A. Edelmann, Nuclear Science and Engineering Corporation, Post Office Box 10901, Pittsburgh 36, Pa.

## Curare

An International Symposium on Curare and Curare-like Agents will take place in Brazil 5-17 Aug. The organizing bodies are UNESCO, the Conselho Nacional de Pesquisas (National Council of Research, Brazil), the Academia Brasileira de Ciencias, and the Universidade do Brasil, Rio de Janeiro. The congress is being held under the patronage of the President of the United States of Brazil.

Meetings will be held between 5 and 10 Aug. at the University of Brazil and will consist of a series of reports and communications on (i) the ethnographic problems concerning South-American curares, (ii) the botanical origin of the active principles of curares, (iii) the chemistry of the curarizing alkaloids, (iv) synthetic curares, (v) physiology of neuromuscular transmission and mechanism of curarization, (vi) pharmacological properties, (vii) clinical applications of curares.

A number of specialists in these different fields have already promised their participation. During the second week, from 11 to 17 Aug., a visit to Manaus (Instituto Nacional de Pesquisas de Amazonia) and to Belem (Instituto Agronomico do Norte) will be arranged for the participants.

The official languages of the symposium are Portuguese, English, French, and Spanish. The papers presented will subsequently be published by UNESCO and the Paterno Foundation of the Istituto Superiore di Sanita, Rome, Italy.

Correspondence should be addressed to Prof. C. Chagas, Instituto de Biofisica, Universidade do Brazil, 450 Avenida Pasteur, Rio de Janeiro. Europeans should write to Prof. Daniel Bovet, Istituto Superiore di Sanita, 299 Viale Regina Elena, Rome, or to Prof. P. B. Carneiro, Délégation du Brésil, UNESCO, 19 Avenue Kléber, Paris 16ème, France.

## Society Elections

■ **Chicago Natural History Museum:** pres., Stanley Field; 1st v. pres., Hughston M. McBain; 2nd v. pres., Walter Buchen; 3rd v. pres., Joseph N. Field; treas., Solomon A. Amith; sec. and dir., Clifford C. Gregg; asst.-sec., John R. Millar.

■ **American Association of Petroleum Geologists:** pres., Graham B. Moody; v. pres., Byron W. Beebe; sec.-treas., William J. Hilseweck.

■ **Society of Economic Paleontologists and Mineralogists:** pres., Richard V. Hollingsworth, Paleontological Laboratory, Midland, Tex.; past pres., Robert R. Shrock, Massachusetts Institute of Technology; v. pres., Stuart A. Levinson, Humble Oil and Refining Company; sec.-treas., Samuel P. Ellison, Jr., University of Texas, Austin.

■ **American Physical Society:** pres., Henry D. Smyth, Princeton University; v. pres., Jesse W. Beams, University of Virginia; treas., S. L. Quimby, Columbia University; sec., K. K. Darrow, New York, N.Y.

■ **Oklahoma Academy of Science:** pres., D. E. Howell, Oklahoma Agricultural and Mechanical College; sec., J. Teague Self, University of Oklahoma; sec.-treas., Philip Smith, University of Oklahoma School of Medicine; asst. sec.-treas., Don E. Mitchell, Continental Oil Company.

■ **Society for the Advancement of Criminology:** pres., Richard O. Hankey, Law Enforcement Training College; sec.-treas., William Dienststein, Fresno State College, Fresno 4, Calif. The vice presidents are John P. Kenney, David McCandless, and Donal E. J. MacNamara.

## Forthcoming Events

### March

22-23. **Heart: Law-Medicine Problem**, Cleveland, Ohio. (O. Schroeder, Jr., Law-Medicine Center, Western Reserve Univ., Cleveland 6.)

23-28. **American Soc. of Tool Engineers**, 25th annual, Houston, Tex. (R. Gebers, 10700 Puritan, Detroit 38, Michigan.)

24-27. **American Assoc. of Dental Schools**, annual, Atlantic City, N.J. (M. W. McCrea, 42 S. Greene St., Baltimore 1, Md.)

25-28. **American Acad. of General Practice**, 9th annual scientific assembly, St. Louis, Mo. (M. F. Cahal, AAGP, Volker Blvd. at Brookside, Kansas City 12, Mo.)

25-29. **International College of Allergy**, 3rd symposium, London, England. (W. Kaufman, 540 Brooklawn Ave., Bridgeport 4, Conn.)

25-29. **Western Metal Exposition and Congress**, 10th, Los Angeles, Calif. (W. H. Eisenman, 7301 Euclid Ave., Cleveland 3, Ohio.)

26-28. **Mechanisms for the Development of Drug Resistance in Microorganisms**, Ciba Foundation Symp. (by invitation), London, England. (G. E. W. Wolstenholme, 41 Portland Pl., London, W.1.)

26-28. **Weather Radar Conf.**, 6th, sponsored by American Meteorological Soc., Cambridge, Mass. (K. C. Spengler, 3 Joy St., Boston 8, Mass.)

27-29. **American Power Conf.**, 19th annual, Chicago, Ill. (R. A. Budenholzer, Illinois Inst. of Technology, 35 W. 33 St., Chicago 16.)

27-29. **Effects of Radiation on Materials**, colloquium, Baltimore, Md. (Office of Naval Research, Glenn L. Martin Co., Baltimore 3.)

27-29. **National Committee on Alcoholism**, annual, Chicago, Ill. (Miss E. Jensen, NCA, 2 E. 103 St., New York 29.)

### April

1-2. **Industrial Engineering Conf.**, West Lafayette, Ind. (K. E. Glancy, Div. of Adult Education, Purdue Univ., West Lafayette.)

1-4. **American Assoc. of Petroleum Geologists**, 42nd annual, St. Louis, Mo. (R. H. Dott, AAPG, Box 979, Tulsa, Okla.)

1-4. **International Anesthesia Research Soc.**, cong., Phoenix, Ariz. (A. W. Friend, Wade Park Manor, Cleveland 6, Ohio.)

1-4. **Society of Economic Paleontologists and Mineralogists**, annual, St. Louis, Mo. (C. P. Ellison, Jr., Dept. of Geology, Univ. of Texas, Austin.)

1-5. **Assoc. of American Geographers**, annual, Cincinnati, Ohio. (B. W. Adkinson, Reference Dept., Library of Congress, Washington 25.)

2-3. **Future Developments in Food Preservation**, symp., Kansas City, Mo. (Food Symposium, Midwest Research Inst., 425 Volker Blvd., Kansas City 10.)

4-5. **Dietary Fats—Helpful or Harmful**, 3rd annual nutrition conf., Detroit, Mich. (A. H. Smith, Wayne State Univ. College of Medicine, Detroit 7.)

4-6. **American Rocket Soc.**, spring, Washington, D.C. (A. G. Haley, 1735 De Sales St., NW, Washington 6.)

5-6. **American Mathematical Soc.**, New York, N.Y. (J. H. Curtiss, AMS, 190 Hope St., Providence 6, R.I.)

7-10. **Pan American Assoc. of Ophthalmology**, 4th interim cong., New York, N.Y. (B. F. Payne, 17 E. 72 St., New York 21.)

7-12. **American Chemical Soc.**, Miami, Fla. (A. H. Emery, ACS, 1155 16 St., NW, Washington 6.)

8. **Phi Lambda Upsilon**, Miami, Fla. (T. B. Cameron, Dept. of Chemistry, Univ. of Cincinnati, Cincinnati 21, Ohio.)

8-10. **American Soc. of Mechanical**



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Engineers, spring, Birmingham, Ala. (C. E. Davies, ASME, 29 W. 39 St., New York 18.)

8-12. Food Bacteriology, internat. symp., Cambridge, England. (Dr. Mossel, Central Inst. for Nutrition Research T.N.O., Catharijnesingel 61, Utrecht, Netherlands.)

8-12. Surface Activity, 2nd world cong., London, England. (Congress Secy., 14 Belgrave Sq., London, S.W. 1.)

9-10. Industrial Electronics Education Conf., annual, Chicago, Ill. (E. A. Roberts, Armour Research Foundation, Illinois Inst. of Technology, Chicago 16.)

10-12. Nuclear Instrumentation Conf., natl., Atlanta, Ga. (H. Kindler, Instrument Soc. of America, 313 Sixth Ave., Pittsburgh, Pa.)

10-13. Conference on Embryology and Experimental Morphology, Cambridge, England. (D. R. Newth, Dept. of Zoology, University College London, Gower St., London W.C. 1.)

11-13. American Assoc. of Pathologists and Bacteriologists, annual, Washington D.C. (E. A. Gall, Cincinnati General Hospital, Cincinnati 29, Ohio.)

11-13. Southwestern Inst. of Radio Engineers Conf. and Electronics Show, 9th annual, with 2nd National Simulation Conf., Houston, Tex. (F. C. Smith, Jr., Box 13058, Houston 19.)

12-13. Colorado-Wyoming Acad. of Science, annual, Fort Collins, Colo. (O. W. Olsen, Colorado A.&M. College, Fort Collins.)

12-13. Eastern Psychological Assoc., annual, New York, N.Y. (G. G. Lane, Dept. of Psychology, Univ. of Delaware, Newark.)

12-13. New Orleans Acad. of Sciences, New Orleans, La. (A. Welden, Dept. of Biology, Newcomb College, New Orleans, La.)

12-14. American Assoc. for Cancer Research, Chicago, Ill. (H. J. Creech, Inst. for Cancer Research, Fox Chase, Philadelphia 11, Pa.)

12-14. American Assoc. of Physical Anthropologists, annual, Ann Arbor, Mich. (J. H. Spuhler, Dept. of Human Genetics, Univ. of Michigan Medical School, Ann Arbor.)

12-14. American Soc. of Human Genetics, annual, Ann Arbor, Mich. (E. J. Gardner, Dept. of Zoology, Utah State College, Logan.)

12-14. National Speleological Soc., Natural Bridge, Va. (Mrs. M. McKenzie, 1407 Hickory Ct., Broyhill Park, Falls Church, Va.)

13. Society for the Scientific Study of Religion, spring, New York, N.Y. (W. C. Clark, Hartford School of Religious Education, Hartford 5, Conn.)

13. South Carolina Academy of Science, annual, Columbia (Miss M. Hess, Box 114, Winthrop College, Rock Hill, S.C.)

14-16. Telemetry Symposium, natl., Philadelphia, Pa. (A. S. Westneat, Jr., Applied Science Corp., Box 44, Princeton, N.J.)

14-20. American Physiological Soc., Chicago, Ill. (M. O. Lee, APS, 9650 Wisconsin Ave., NW, Washington 14.)

(See issue of 15 February for comprehensive list)

## EQUIPMENT NEWS

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Science does not assume responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to Science, Room 604, 11 W. 42 St., New York 36, N.Y. Include the name(s) of the manufacturer(s) and the department number(s).

■ **TEMPERATURE-CONTROLLED AIR CHAMBER** is designed to operate to 1000°F. The interior cabinet is made of 1/8-in., heliarc-welded stainless steel. Chamber size is 4 by 4 by 3 ft. Uniform temperature is achieved by means of a plenum air chamber and mechanical circulation. Numerous fittings provide for remote electric and mechanical connections. (Labline, Inc., Dept. S158)

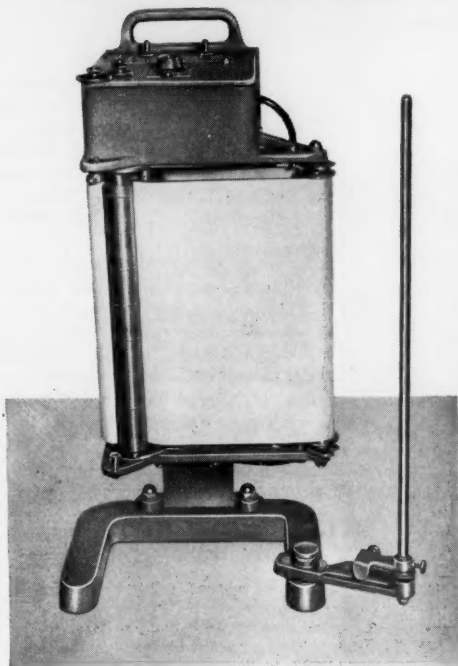
■ **PERMANENT MAGNET MATERIAL**, alnico 5 Cb, said to have the highest energy product of any alnico, is described in a 4-page bulletin. Physical properties, dimensional limitations, and a typical demagnetization and energy-product curve are described. Comparative properties of other permanent-magnet materials are included. (Thomas and Skinner, Inc., Dept. S160)

■ **RADIOACTIVE CHROMATOGRAPH SCANNER** is designed to provide automatic graphic presentation of the distribution of activity along a paper chromatogram that is tagged with low-energy beta-emitting isotopes. It employs a small, low-background flow counter that can be operated without a window. Chromatograms up to 3 in. wide and 5 ft long can be accommodated. The scanning head is removable, and windows, when used, are easily replaceable. Rectilinear recording at 10 different scanning speeds is provided. Scanning is automatically interrupted when the end of the chromatogram is reached, and a signal alerts the operator. (Forro Scientific Co., Dept. S163)

■ **PHOTO PRINTER** utilizes electronic control in "dodging" negatives during printing. A brilliant spot of light projected from a flying-spot-scanner cathode-ray tube produces the exposure. The spot scans the negative and the printing material. Variations of density in the negatives are sensed and evaluated in electronic circuits that compare the light value provided with the optimum for the printing material. This information is fed back to control the intensity of the printing beam, thus automatically correcting the exposure of each small sample area of the negative. Application to improving interpretability of x-ray photographs, for example, is apparent. (Norden-Ketay Corp., Dept. S164)



## BIRD V-H KYMOGRAPH



CONTINUOUS feed . . . used for vertical and horizontal recording.

While designed for 10-inch paper this Bird Kymograph will feed narrower widths.

Eight speeds are provided giving paper speeds from 2 to 450 cm/min.

Precision of paper movement is not affected by use or non-use of take-up roll because separate motors are employed.

The Bird Kymograph V-H is furnished with an attractive aluminum and cast iron stand which has a handle at top for easy carrying.

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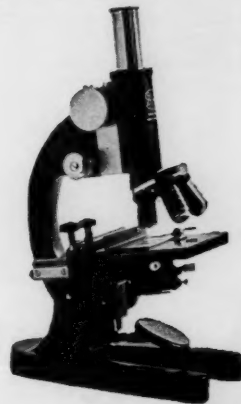
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864 pages Author and subject index \$12.50

THE JOHNS HOPKINS PRESS, Baltimore 18, Md.

■ **ACCURACY AND SENSITIVITY TERMINOLOGY AS APPLIED TO INDUSTRIAL INSTRUMENTS** is the title of SAMA Tentative Standard RC3-12-1955. Such standards remain tentative for 2 years before they become SAMA industry standards. (Scientific Apparatus Makers Association, Dept. S157)

■ **COORDINATE PLOTTER** plots points along orthogonal coordinates within 0.001 in. Working area is a 47½- by 47½-in. table. Points are marked by a prickler that is combined with a 7-power microscope. (Aero Service Corp., Dept. S169)

■ **STOPCOCK GREASE** made with a silicone base is suitable for use at temperatures up to 360°C and at pressures down to 0.5 mm-Hg. (Glass Engineering Laboratories, Dept. S155)

■ **STRIP-CHART RECORDER** records within a limit of error of 1 percent and provides full-scale balancing time of 1 sec. A potentiometer model has a span adjustable from 9 to 100 mv. Source resistance may be as high as 100 kohm. Speeds from ⅓ in./hr to 8 in./min are available. Chart width is 5 in. (Varian Associates, Dept. S176)

■ **TEMPERATURE TEST CHAMBER** for ambient testing of products from -65°F to 600°F has 600 in.<sup>3</sup> of working space. Temperature fluctuations are limited to 4°F. Dry Ice is used for cooling, and two 750-watt finned-strip heaters are used for heating. The test trays are interchangeable, and they have ⅜-in. openings for electric or mechanical connections. (Statham Development Corp., Dept. S156)

■ **ACTIVITY CAGE** is an instrument for measuring the locomotor activity of rats. The cage, a 6-in. cube, will accommodate rats up to 400 g in weight. The cage suspension is a resilient cantilever beam that permits a slight sidewise motion of the cage in response to animal activity. The motion is integrated, and the integrated accelerations are recorded on a circular chart recorder. (Williamson Development Co., Inc., Dept. S165)

■ **AURORAL PATROL SPECTROGRAPH** designed especially for the International Geophysical Year produces a horizon-to-horizon photographic record of the spectra of auroras along a meridional line. The camera can be adjusted to photograph spectra from the visible to the near infrared. Exposure is determined by a photometer. Exposure of a standard tungsten lamp provides an index to film characteristics. The instrument is designed to operate in extremes of temperature from -40°F to +125°F. (Perkin-Elmer Corp., Dept. S166)

■ **SCINTILLATION PROBE** has a 1- by 1-in. thallium-activated sodium iodide crystal and a background of less than 200 count/min without collimator or sample counting shield. (Atomlab, Inc., Dept. S167)

■ **LOW-BACKGROUND COUNTER** for measurement of carbon-14 of very low specific activity reduces background to less than 1 count/min. Ultimate sensitivity is 0.05 count/min. Two separate counters, operating under an anticoincidence umbrella of 16 TGC-16 Geiger tubes, are used. The whole is shielded against terrestrial gamma radiation by mild steel bricks. Window thickness is less than 1 mg/cm<sup>2</sup>. Long-term stability results from the plateau slope of less than 1 percent per 100 v. (Tracerlab, Inc., Dept. S161)

■ **pH METER** can be adapted for potentiometer recorder output, automatic temperature compensation, and Karl Fischer titrations. Range of the line-operated instrument is 0 to 14 pH units and 0-to-1400 or 700-to-0-to-700 mv. Zero can be set to any point on the 0-to-1400 mv scale. Accuracy is given as 0.1 pH unit. A glass electrode and a reference of electrode are furnished. (Beckman Instruments, Inc., Dept. S173)



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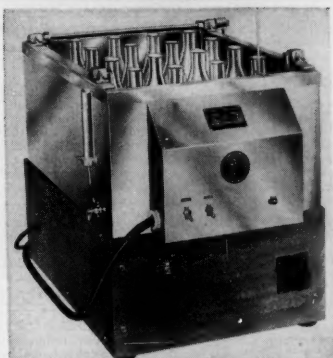


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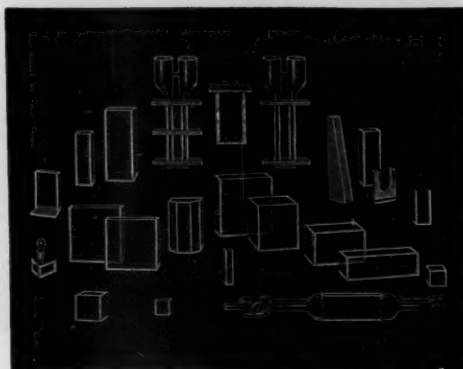
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**Administrator of Research Program** for voluntary health agency in New York City. Ability to handle details of grant and fellowship awards and interpretation of technical reports for lay consumption. State age, education, degrees, experience if any, and salary requirement. Box 76, SCIENCE. X

**Biochemist**, semiretired, for Florida clinic doing research on the arthritides. Pleasant living conditions, complete laboratory facilities. Steroid chemist preferred. Box 75, SCIENCE. X

**Biochemist**, Ph.D., for research in problems of the aged. Send résumé and references to Director, Home for the Jewish Aged, 5301 Old York Road, Philadelphia 41, Pa. X

(a) **Chemist or Biochemist:** medical school research department; present projects involve research on steroids, hormones; if Ph.D., \$8000; West. (b) **Senior Research Associate**, division of physiology and pharmacology, pharmaceutical company; preferably Ph.D. in physiology with training in biochemistry; East. (c) **Microbiologist**, Ph.D.; faculty post, university medical school; duties: teaching of medical students, research; Midwest. (d) **Clinical Chemist** to direct hospital laboratory; preferably one interested in cancer research, teaching related to cancer; teaching programs planned for clerical and nonclerical levels; 500-bed teaching hospital; East. (e) **Bacteriologist**; supervising post; new department, 350-bed hospital; near Chicago; \$6000-\$7500. S2-4, Medical Bureau, Burneice Larson, Director, 900 North Michigan Avenue, Chicago. X

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Company benefit program provides broad coverage. Applicants should submit full information outlining education and experience and an indication of desired salary. Address replies to

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**Medical Microbiologist**, M.D. or Ph.D. for department of microbiology in large midwest medical center hospital. Applicant should have experience in the broad field of diagnostic microbiology and an interest in research and teaching. Salary open. Box 73, SCIENCE. 3/1, 8, 15

### MICROBIAL TAXONOMIST

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### POSITIONS REQUIRING DEGREES IN MEDICINE OR SCIENCE:

(a) **Pharmacology Instructor:** young male Ph.D. preferred; outstanding eastern medical school, excellent hospital affiliations; \$5000-\$5500. (b) **Bacteriologist:** experienced hospital bacteriology, to head section, very large, fully approved general hospital; supervise one to two technicians; to \$6000; Chicago area. (c) **Chemist:** B.S., M.S., and experience; knowledge toxicology clinical chemistry, physical methods; cognizant latest chemical procedures; county health laboratory; to \$6200; eastern resort area. (d) **Research Pharmacologist:** M.D. or Ph.D., research laboratory, well-known pharmaceutical house; to \$10,000 or more; East. (e) **Biochemist:** Ph.D., to head department, 250-bed general hospital; to \$11,000; university, cultural center; Midwest. Woodward Medical Bureau, 185 North Wabash, Chicago. X

**Senior Pharmacologist.** Opportunity with ethical pharmaceutical company, West Coast, Ph.D. or equivalent. Please send full résumé to Personnel, P.O. Box 3157 Terminal Annex, Los Angeles 54, Calif. 2/22; 3/1

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**Microbiologist**, B.S. or M.S. with some experience in tissue culture or microbiological work. Position includes maintenance of tissue culture strains and preparations of cultures for use in viral research, assisting in general virological experiments, egg inoculation and harvesting, tissue culture, and animal and microscopic studies. Please send complete résumé to Personnel Director, Ortho Pharmaceutical Corporation, Raritan, New Jersey. 2/15, 22

**Microbiologist**, Ph.D. in bacteriology, male. Research on microbial growth factors in nutrition research department of midwestern company. Send résumé. Box 58, SCIENCE. 2/22; 3/1

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**Biologist**, Ph.D., botany, microbiology; 5 years' extensive research in microbial physiology. Broad interests; adaptable; enthusiastic; publications. Desires teaching position or research position in academic institution. Box 60, SCIENCE. X

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**Microbiologist:** Ph.D., 33, teaching, research and administrative experience in university medical school and government research organization; microbial physiology, general bacteriology, biochemistry, tissue culture, isotopes; publications. Desires responsible administrative and research position. Box 66, SCIENCE. X

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**Microbiologist**, Ph.D., 38, general microbiology, specialty in cytology, active interest in ecology. Teaching and research experience; publications. Desires academic position with opportunity for research. East preferred. Box 62, SCIENCE. X

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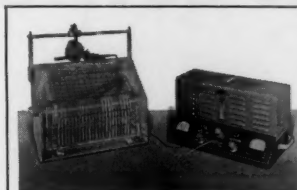
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"This volume is not a reference intended for use at the introductory student level. It can be reviewed with interest, however, by any serious member of the reading public." *American Journal of Pharmaceutical Education*, July 1956.

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## ANNOUNCEMENT CONCERNING

# SPECTROCHIMICA ACTA

The changing emphasis in spectroscopy, caused especially by the vast increase in studies of molecular spectra of many kinds, has made it desirable, as already announced, to re-organize the operation of this journal as from January 1957 in order that all aspects of atomic and molecular spectra may be covered adequately and to enable authors to obtain rapid publication. Emission and absorption spectroscopy over the entire 'optical' wavelength range will be accepted, and spectroscopy in the microwave region insofar as it has a direct physico-chemical interest. Raman and fluorescence spectroscopy will also, for example, be included. The main applications will include qualitative and quantitative analysis, the determination of molecular structure and of fundamental atomic or molecular data, as well as the design of equipment, description of new experimental methods or the elucidation of general spectral theory and matters relating thereto.

It is also planned that this international journal shall be a medium for the prompt publication of short communications, reports on spectroscopic meetings, reviews, and official reports of International Commissions. It is hoped to publish monthly issues, with a delay of not more than three months after receipt of manuscripts.

The editorial board has been revised, and includes spectroscopists in the U.S., U.K., Europe, Asia and elsewhere, with main editors in both the U.S.A. and U.K.

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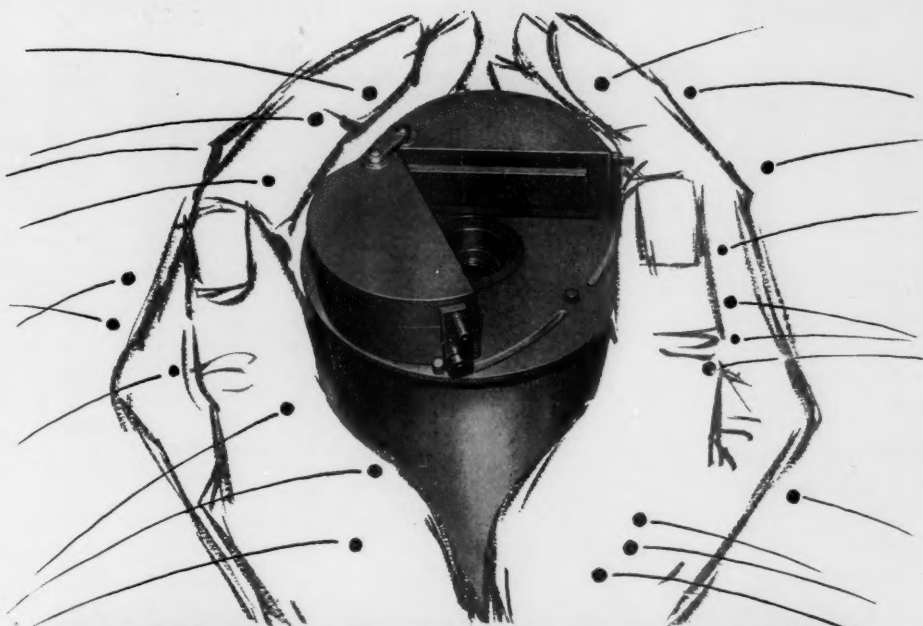
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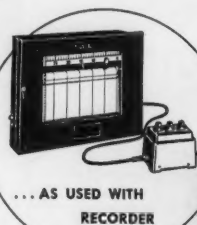
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